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OBSERVATIONS ON LORAMYCES, AN UNDESCRIBED AQUATIC ASCOMYCETE [1]

WILLIAM H. WESTON, JR.[2]

(WITH PLATES 8 AND 9)

INTRODUCTION

In the course of occasional investigations in the various orders of submersed Phycomycetes, a group which to him are among the most interesting of the fungi, the writer has carried on intermittent search for aquatic fungi in other groups and from time to time has encountered representatives of the Fungi Imperfecti and a certain number of Ascomycetes which proved, for the most part, to be either commoner aquatic forms already known, such as *Mitrula* and *Vibrissea;* or forms normally terrestrial perforce persisting for a time in a facultatively aquatic life because the wood or other substratum on which they were growing had become temporarily submerged.

One of the Ascomycetes, however, has been found to be of considerable interest because of its restricted relation to one special substratum within a very limited region, and because of the marked peculiarities of its structure and reproduction in conformity to its obligately aquatic mode of life.

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Although this form was first found twelve years ago its study has been regrettably fragmentary, as the demands of work in other fields have left no opportunity for the intensive investigation of the cytological details of spore formation or the physiological aspects of spore discharge and distribution, which these interesting features demand. Yet as the fungus appears to be one as yet undescribed and as it shows such marked peculiarities of structure, development, and distribution it is hoped that other mycologists may find points of interest in even the incomplete observations embodied in the following paper.

THE OCCURRENCE OF THE FUNGUS

This fungus has been found only on dead, partly softened, though not too old, culms of *Juncus militaris* Bigelow, lying submerged, from a few inches to as much as three feet, in fresh water chiefly in a small pond on Nashawena Island, one of the farther of the Elizabeth Islands situated off the Massachusetts coast, southwest of Woods Hole. It was first found in July 1915 by Ivey Lewis, R. H. Colley, and the writer while conducting a collecting foray of the Alga Course of the Marine Biological Laboratory and since then, in the same spot, it has been collected not only by the writer in 1916, 1922, and 1923 in either July or August, but also on similar yearly collecting trips during almost all of the intervening summers, including 1927, by others, while the writer has been elsewhere.

This pond presents certain distinctive features: it is of fresh water, situated a short distance inland behind rolling sand dunes, and bordered by thickets of shrubs such as bayberry, in depth rather shallow around the edge but deepening rapidly toward the center. In the shallows about the margin especially on the side toward the sea there grows a dense stand of *Juncus militaris* which lessens and hinders any washing movement of waves, partially shades the water, and furnishes an abundant accumulation of submerged culms year after year.

Although in these shallows the water at its very uppermost surface at midday in summer may become well warmed by the sun, further below, especially in the shade of the *Juncus*, its coolness rapidly increases until at a depth of two or three feet

it is usually unpleasantly cold even in July and August. In winter, although no accurate records have been kept for this pond, we may assume from what has been observed in the case of other ponds of similar size and situation that ice forms, even in extremely cold seasons, to a depth of as much as a foot.

The water is fresh and relatively free from sediment although, because of the organic material it contains, its color usually is a rather dark brown.

In spite of the fact that species of *Hapalosiphon*, *Stigonema*, and *Stigeoclonium* frequently are found on the submerged *Juncus* stems near the surface in company with the fungus, the algal flora of the pond is rather scanty, possibly because the water is so dark colored, so shaded by the *Juncus* at the margin and so rapidly deepening toward the center. Nor do the algae, as far as is known, show cases of such restricted distribution as this fungus, although it should be noted, as Dr. Lewis has informed the writer, that *Batrachospermum*, probably because the water is cool and shaded and the distributing wave motion arrested, commonly grows here, the only place save the *Chamaecyparis* swamp in which this form is found around Woods Hole.

Juncus militaris Bigelow, of course, is by no means limited to this pond, but occurs rather commonly in the Woods Hole region, indeed throughout the northeastern states as well.

As other ponds both on the Elizabeth Islands and on the mainland around Woods Hole have the same fringe of *Juncus militaris* and seem, in general, to present approximately the same conditions as those described, it appeared probable that in time the fungus would be found to occur elsewhere in the region, but in spite of an interested, though intermittent, search during several seasons the species was not encountered in any other spot until last summer when in August Dr. Lewis found it not only in the same pond on Nashawena Island, but also in a somewhat similar pond, called "French Watering Place," situated on the south side of Naushon Island, the largest of this same series of Elizabeth Islands. As might have been expected, the substratum was the usual submerged and softened culms of *Juncus militaris* Big. from the marginal shallows. On carefully comparing the type with Dr. Lewis' specimens from this new locality, there is no doubt that they are indeed the same.

STRUCTURE AND DEVELOPMENT OF THE FUNGUS

The fungus, as it is seen under natural conditions on the submerged *Juncus* culms, shows small, dark, turbinate or flattened spherical fruiting bodies of varying ages and sizes occurring either singly or a few together in more or less close groupings though never fused. In position the perithecia show no polarity, nor special orientation, as they occur without any relation to gravity or the direction of light on the top, bottom, and sides of the culms (FIG. 1) as these lie more or less horizontally on each other under the water.

When examined more closely under binocular or hand lens fruiting bodies are found to show some range of size and shape in the course of their development, beginning as almost spherical initials perhaps as small as one fifth of a millimeter in diameter and becoming larger and somewhat modified in form until when mature they are usually about 1.5 to 2 mm. in diameter, and vary from slightly flattened spherical to turbinate or onion shaped. When young the perithecia are quite closed but as each matures it develops at its apex an ostiole which is rather large (20 to 30 μ in diameter) and somewhat protruding. In color they are uniformly black when young, and at maturity this tone either may remain throughout or, perhaps more commonly, may persist below while the upper portion shades into rather dark brown, the fully-formed ostiole appearing gray as the hyaline interior shows through.

As the spores are discharged they may show for a time as a grayish mass spreading out from the ostiole, whereas, after all the spores have emerged and scattered, the upper, more pallid portion of the fruiting body may disintegrate gradually until finally in old passé perithecia only the lower three quarters persists as a partly closed cup containing some fragmentary remains of the pallid content.

In texture and consistency the perithecia are not carbonaceous, but rather fleshy or perhaps gelatinously cartilaginous, and suitable staining or mounting in India ink demonstrates a thin (30 to 50 μ), rather soft, gelatinous envelope completely surrounding them.

The fruiting bodies are set upon a somewhat sparse subiculum

of black, rather thick walled, toruloid, anastomosing hyphae, which are apparently almost wholly superficial, sending only occasional colorless branches down into the substratum. In carefully cut sections, however, there may be traced an inconspicuous mycelium of fine, pale brown or gray to hyaline hyphae running down into the *Juncus* culm both between and within the cells, below the perithecium.

The structure of the mature perithecia when studied in more detail by means of free hand sections of fresh material, microtome sections of material killed, imbedded and stained, and fragments of living fruiting bodies carefully crushed and picked apart, was found to show the following features. The base of the perithecium, of much the same structure as the subiculum from which it arises, rounds up into a somewhat dome-shaped, darkened cushion, surmounted by a subhymenial region of densely interwoven, fine, hyaline ascogenous hyphae, from which grow out the asci and paraphyses in a closely packed somewhat bulging or arching cushion that practically fills the interior of the fruiting body. Surrounding this interior and closely appressed in conformity to it, there is an inner wall, a relatively thin layer of fine hyaline hyphae running for the most part longitudinally but somewhat interwoven, while exterior to this, enclosing the whole, is the outer wall of the perithecium, a dark, compact pseudotissue like that in the base, of which, indeed, it is structurally a continuation.

From the surface of this outer wall arise numerous short, slender, hyphal outgrowths which presumably may function as "mucilage hairs" and by the gelatinization of their pallid walls produce the hyaline gelatinous investment which, as already mentioned, lies as a clear zone around the outside of the perithecium. Around the ostiole some hyphae from both the hyaline inner layer and the darkened outer layer of the perithecial wall run out into a slightly protrusive circlet of pale hairs.

The content of the perithecium is involved in a clear gelatinous matrix which holds the crowded asci and paraphyses firmly imbedded together and fills the slight remaining space within the wall. As far as could be ascertained this material originates from the hyphae of the hyaline inner wall and from the

paraphyses. At first, when the perithecium is young, this matrix stains rather deeply and is apparently fairly firm, for the whole content may be pressed out in one closely cohering mass, but in time, as maturity approaches, it stains less deeply and becomes increasingly diffuse so that if mature individuals are crushed the content comes out in small, loosely adherent clumps.

The paraphyses (FIGS. 7, 8) are filiform, slightly sinuous or wavy, or somewhat bent, usually about 150 μ long (130 to 160 μ), slender, the diameter of usually 1.5 to 2 μ varying but little throughout, thin-walled, hyaline and while precise determination was difficult they were seemingly continuous although occasionally they contain here and there denser aggregations which in some cases might possibly be nuclei or more probably merely clumps of granules giving an impression of septa.

The asci (FIGS. 3, 4) are long clavate, slightly curved, and with rounded tip below which the diameter continues very nearly equal down to a little below the middle, from there tapering gradually to the somewhat sinuous, wavy base that ends in the usual angular bend at the point of attachment. In size they show relatively little variation, the length ranging from 120 to 150 μ and the greatest diameter from 8 to 11 μ.

The wall is hyaline, thin, tough, elastic, and shows no distinguishable modifications in structure or composition save that in the tip, at dehiscence, there develops a pore around which the wall persists as a firm collar (FIG. 6).

Each spore when mature consists of an irregularly spindle-shaped main body comprising two approximately equal cells somewhat constricted at the dividing septum, the distal one terminating in a bluntly rounded tip, the proximal one tapering to a long, filiform, caudate, slightly curved or sinuous appendage which projects behind (FIGS. 9, 10, 12).

The material which had been collected had not been suitably killed and fixed for an exacting, cytologic study, and when imbedded, sectioned, and stained, or crushed out, and picked apart, and stained, did not permit the determination of such cytological details as the exact orientation and behavior of the nuclei in the successive divisions to 8, the number of chromosomes

in the nuclei, and the precise activity of the kinoplasmic rays in delimiting the spores, but certain points in the formation of the spores and of their appendages could be made out. By the time that the 8 nuclei have been established by successive nuclear divisions and the 8 spores are being cut out, they are found to be closely set together, usually in two successive groups of 4 each, somewhat irregularly overlapping, in the expanded distal portion of the ascus which at this stage is short and abruptly swollen. The spores at first are uninucleate and the body of the spore is one-celled, but the nucleus divides, and the body of the spore becomes two-celled by the formation of a median cross wall. Meanwhile the ascus is elongating so that the spores become arranged seriately in the mature position mentioned later. The two-celled condition is very constant, for in the hundreds of spores, both immature and mature, which have been examined, no one-celled spores were seen and only two or three cases comprising three cells in spores of somewhat abnormal shape. As the spores are delimited and the nucleus becomes localized in the thicker distal end, this is distinguished from the very first as the body of the spore of which the appendage is an exceedingly attenuate prolongation. When the spore becomes two-celled, the appendage, as a slender continuation of the second or proximal cell of the spore body, is in no sense a separate cell and does not in its earliest demarcation possess a nucleus that later would degenerate. Rather, it is from the beginning quite without any nucleus and is but a prolongation of the second cell, a condition somewhat similar to that which has been worked out by various investigators in the spores of certain species of Podospora. The appendage is not composed merely of wall substance, but has a lumen which is exceedingly tenuous but does apparently contain substance very finely granular, homogeneous in most cases, but occasionally with larger, more obviously granular inclusions (FIG. 12), and may be cut off from the second cell of the spore body by a definite wall or may, as far as can be determined, be continuous with it, although quite distinct from it, not only in slenderness, but also in the fact that the wall substance does not form a thick capsule and the envelope of gelatinous material around the body of the spore

shows evidence of being a modification of the outer portion of the wall of this region, with quite distinct demarcation that may be detected as a flaring modification where the spore body begins, as shown in figures 9 to 12.

In size the main body of the spores was found to show such uniformity that only a few careful measurements were tabulated, the greater proportion being consistently from 17 to 22 μ long and 4 to 6 μ in diameter The appendages, however, while relatively uniform (0.5 to 0.75 μ) in diameter, show considerable variation (from 40 to 80 μ) in length, although the majority are between 50 and 65 μ long, that is, between two and one half to a little over three times as long as the spore body.

DIMENSIONS OF SPORES

Spore Body (Not Including Capsule)				Appendage	
Length		Diameter		Length	
Class μ	No. of Spores in 25	Class μ	No. of Spores in 25	Class μ	No. of Spores in 25
16–17.9	7	4–5.9	23	34–41.9	1
18–19.9	6	6–7.9	2	42–49.9	2
20–21.9	8			50–57.9	11
22–23.9	4			58–65.9	7
				66–73.9	2
				74–81.9	2

In shade the spores are consistently hyaline, with clear, rather thin wall and content, in the body cells, of a finely granular groundwork in which longer granules are scattered in more or less irregular groups, while by suitable staining a single inconspicuous nucleus can be demonstrated in the center of each cell (FIG. 10) while occasionally one or more guttulae are present (FIGS. 14, 15). The appendages are thin-walled and within the tenuous lumen the content usually appeared homogeneous although in some instances inconspicuous granular inclusions were visible here and there (FIG. 12).

Around the body of the spore there is a thick capsule or envelope of gelatinous material which is not diffluent but decidedly persistent, of definite limits, and apparently rather

firm, yet so clear that, although its presence may be assumed from the behavior of the spores and the positions they take in relation to each other when grouped, it is almost invisible, only a very faint suggestion of its outline being apparent even when especially good definition is secured. On treatment with acidulated methyl blue or methyl green, however, this gelatinous coating is differentiated clearly and can be seen to be ellipsoidal or broadly fusiform in shape, its greatest diameter of three to four times that of the spore occurring opposite the septum, the point bluntly rounded off close to the apical cell while toward the base it narrows down to the attachment of the tail-like appendage. The composition of this capsule is not homogeneous for when stained rather striking zones and radiations of decidedly contrasting depth of color stand out clearly within it (FIG. 16). The appearance of these stained capsules, especially at the juncture of the body and the appendage, gives the impression that they are gelatinous modifications around the spore body of an outer wall which continues unmodified to form the appendage.

Within the ascus, the spores lie in a series of eight, somewhat overlapping yet evenly spaced, in a rather neat arrangement in conformity to their peculiar structure and form. The body of each spore usually lies somewhat obliquely across the interior of the ascus, the basal cell of one lying alongside the apical cell of the next spore below, the eight spore bodies sometimes placed parallel to each other to form a linear series down the ascus (FIG. 4), and sometimes placed with each successive body slightly more rotated around the central axis of the ascus in a gradual spiral as in figure 3. Obviously in these arrangements the gelatinous envelope around the body of each spore is forced obliquely against those of the two adjacent, with which it is in contact, conforming to the space between them, yet not confluent with them, for even in unstained asci mounted in water slight spaces of separation (cf. FIG. 4), or faintly differentiated lines of contact (cf. FIG. 3), may be discerned. In such slight gaps a clear or very finely granular intersporal substance may be seen, while a denser, more coarsely granular material fills the base of the ascus below the series of spores (FIGS. 3, 4).

The appendages, which it should be remembered may be from

one third to even more than one half the total length of the ascus, extend down beside the spores below past the bodies of the two or perhaps three spores next in series. Held against the inner surface of the ascus wall by the tightly compressed gelatinous envelopes of these spores, the appendages may lie approximately parallel in a straight series (FIG. 4), or may be curved around in a gradual spiral as in figure 3. The appendage of the last, most basal spore, if short, may extend straight down but more commonly is doubled back on itself (FIG. 5), or compressed into a short spiral in the denser substance of the ascus base.

In occasional cases among the normal healthy spores within an ascus there occurred one or two that were shrunken, irregular or otherwise abnormal and malformed as if dead or non-functional (cf. spores 3 and 8 in FIG. 3).

As a result of the peculiarities just noted in their structure and arrangement, discharge of the spores from the ascus shows certain rather interesting features. When discharge begins the uppermost spore suddenly snaps out of the tip of the ascus through a terminal pore that is apparently the result of the softening of a small, perhaps specially modified portion of the wall, as no lid-like operculum nor any irregularly torn vent ever could be discerned. The spore does not get entirely free, however, for as it emerges the whole series of spores moves up rapidly behind it and the swollen gelatinous capsule around the body of the second spore jams at its largest diameter in the relatively narrow opening, catching the still emerging appendage of the first. As the pressure from behind continues to increase, this second spore also in its compressible gelatinous envelope is soon forced further and further through the orifice until finally it, too, suddenly snaps forth, its appendage being caught in turn as the third jerks rapidly up taking its place. This catching and ejaculation of successive spores continues at first rapidly and then more slowly as fewer spores are left in the ascus and the expulsive force of the expanding content is lessened. During discharge the expulsive substance that has emerged from the ascus with the spores continues to expand by the imbibition of water so that the column of spores, involved in this barely

discernible and ever more tenuous mass, streams slowly away from the tip of the ascus. Moreover, when free from the ascus the bent or spirally coiled appendages straighten out springily so that the spores have a most striking semblance of swimming away by the slow waving of a posterior flagellum.

From the tips of the discharging asci the stream of spores pushes its way along the scanty space beneath the arched perithecial wall and escapes through the ostiole. It should be noted that all the asci of the hymenium mature at approximately the same time, so that when discharge of spores from the perithecium begins, it continues rapidly until all the asci within have emptied themselves.

Emergence of spores from the perithecium itself begins without any external indications of dehiscence, the spores suddenly commencing to push out through the ostiole one after another and continuing, now in slow succession while but a single ascus is discharging, now more rapidly as two, three, or perhaps more ejaculate simultaneously, now slowly again while only one is active, at times ceasing for a moment, then resuming activity, the evacuation of all the spores in the perithecium requiring for its completion from twenty to perhaps forty-five minutes, depending on the size of the perithecium and the number of spores it contains.

Apparently the process of spore discharge is dependent chiefly upon the penetration of water into the perithecium to reach the mature asci within, for if ripe perithecia are adroitly punctured with the point of a very fine needle, the discharge thus induced will take place immediately through this puncture rather than through the ostiole which still may remain unopened. Or if mature but still undischarged perithecia are crushed, the clumps of asci thus forced out into the water will begin immediately to discharge their spores. Occasionally when discharge is initiated by puncturing the perithecia, or rarely during discharge as it occurs normally, whole asci will emerge, still closed but soon ejecting their spores in the usual manner while free in the surrounding water.

As far as could be determined the gelatinous envelope that surrounds the perithecium gradually softens and becomes more

diffuse in the region of the developing ostiole as the development of the perithecium goes on, until finally at maturity it becomes sufficiently permeable to permit the entrance of water that initiates discharge. The composition and structure of this gelatinous coat that at first so effectively protects the content from the surrounding water, and the nature of the changes which take place as it becomes more and more permeable until at maturity it permits water to enter, would make a most interesting micro-chemical and physiological study.

At the outset of this discharge it is obvious that the spores, in addition to their individual gelatinous encasements, are involved as well in a somewhat more diffuse gelatinous material that exudes with and around them from the ostiole in a mass that constantly increases in volume as more and more flows out. Moreover, absorption of water by this extruded material goes on rapidly so that it becomes ever more spreading and diffluent, until around the periphery, now extremely diffuse, the imbedded spores are no longer held fast. As these spores are set free thus, it becomes obvious from their behavior that they are consistently slightly heavier than water, for although no precise determination of their specific gravity was attempted, always under direct observation whether in hanging drop cultures or in Stender dishes and watch glasses, they could be seen to sink slowly through the water.

In this slow sinking the two-celled body, being of greater mass than the slender appendage, gradually takes the lead, so that the spore soon becomes oriented in its course with the body pointing downward and the slender caudate appendage trailing behind (FIGS. 9, 10). As a result of this orientation the spore comes to rest on its downward-aiming point against whatever substratum it encounters in its slow passage through the water, adhering firmly thereto by means of its gelatinous envelope. Spores thus attached may be found on *Juncus* stems and other submerged objects under natural conditions (FIG. 13), or may be caught in large numbers on slides placed beneath discharging perithecia in battery-jar cultures. When the surrounding water is made to surge actively around spores thus attached, they are not washed away but remain tenaciously

adhering by their points, while the free appendage is swayed and lashed about loosely from side to side.

After becoming attached the spores germinate without any period of rest, beginning to send out a hypha of germination in from two to perhaps five hours. Germination takes place almost invariably from the point of the attached apex of the spore (FIG. 13), for in hundreds examined only a very few cases were observed in which the germ tube had emerged from the second cell of the spore. It seems probable that this definite localization is in response to the orientation of the sinking spore and the resulting contact of the terminal cell with the substratum, for in the few exceptions noted the spores were lying in an unusual almost horizontal position that brought the second cell in contact as well.

The germ tubes grow rapidly, soon (within 30 minutes to an hour) reaching a length from one to two times that of the spore body (FIG. 17), and then sending out crooked branches which run out along the substratum and become cut off by cross walls into somewhat irregular, apparently uninucleate cells, the walls becoming thickened and rather dark (FIG. 18). It is to be noted that not only the first germ tube but also the later mycelium developing from it adheres to the substratum, or to glass surfaces, so firmly as to persist without being dislodged even by violent washing.

Although the growth of mycelia was followed for periods of one or two weeks in hanging drop cultures and ground slides until a fairly extensive mat had been established, no conidial or other types of imperfect reproduction ever were observed to take place.

The early stages in the formation of the perithecia from the beginning of the perithecial initials and possible development of ascogonia and antheridia to the formation of the ascogenous hyphae the writer has not yet had opportunity to follow in detail even though such an investigation promises some interesting results. Apparently, however, development takes place fairly abundantly and rapidly, for even in jar cultures new crops of young perithecia on *Juncus* culms under observation began to grow up within a month.

DISSEMINATION AND PERSISTENCE OF THE FUNGUS

As the fungus is known from this limited region only, it is primarily its relation to the factors of this restricted environment that is of interest. Although no accurate record has been kept, these ponds, as far as could be ascertained from members of the Marine Biological Laboratory staff who have had them and others of the region under occasional observation for the last thirty years or so, have never been known to become dry in the most severe summer droughts, nor to become frozen to more than the relatively small proportion of their depth of ten or twelve inches even in the coldest winters, so that in this time at least no provision on the part of the fungus against drying or freezing has been demanded. Moreover, while we have no exact record of how long the necessary *Juncus militaris* has been growing around the ponds, there are specimens in the M. B. L. herbarium collected as early as 1911 and the present dense stands give every evidence that the species has been established for many years.

It seems probable, therefore, that under these favorable conditions—for much more than the twelve-year period during which it has been collected from the Nashawena pond the fungus has been going through its life cycle—the spores after emergence sinking slowly head down through the water, washing about in slight currents and drifts, until some of them, reaching suitably water-soaked culms of *Juncus*, adhere by the gelatinous coating of their points and then germinate, establishing new mycelia, which give rise in time to mature perithecia of the next generation. Whether this cycle goes on uninterruptedly throughout the year has not been ascertained, but in July and August of the several years in which the fungus has been collected abundant material was found in all stages, with some perithecia, long since empty and disintegrating, others maturing, and still others just beginning to form in an abundance which would seem to indicate that, in these two months at least, the cycle is an uninterrupted one.

Here, then, at least in the Nashawena pond the relatively simple requirements of the fungus seem to be met adequately so that in this small but persistent body of water with an

abundant supply of *Juncus* culms it grows, reproduces, disseminates, and maintains itself from year to year quite successfully. Presumably, as it seems well established in the similar pond in which it was discovered last summer at French Watering Place on Naushon Island, there also the fungus maintains itself successfully.

It seems highly probable that if the fungus were spread to some of the other similar ponds of the region its requirements would be met equally well and it would thrive in these also. The most probable means by which such a transfer might be accomplished would be through spores, or possibly even perithecia, carried in mud or trash clinging to the feet or bodies of animals, especially ducks or other birds, which frequent these ponds. As this, presumably, would involve resistance to partial or complete desiccation for short periods of time at least, a few tests were made of the resistance of both separate spores and of whole perithecia. A supply of spores was secured by allowing mature perithecia to discharge in drops of water on large cover glasses; the empty perithecia were removed and the spore-filled drops allowed to dry in the shade at summer laboratory temperature, protected from dust. When treated thus each spore was found on examination to be firmly attached to the glass by its capsule which could be seen as a dense refractive envelope shrunk and hardened down around the spore body. The content in some spores treated thus developed one or two oil globules in each cell, but in others it showed no visible alteration.

After remaining dry thus for increasing lengths of time the areas of dried spores one after another were covered with drops of sterile water and the covers mounted on Van Tieghem cells, for direct observation. Under these conditions the gelatinous capsules softened, swelled and became once more scarcely discernible, although still holding at least the point of the spore firmly attached to the glass. Germination took place to the following extent: after 2, 4, 6, 8 and 10 hours' drying practically all the spores germinated vigorously; after 24 hours, about half; after 48 hours, a very few only. Apparently germination took place equally well in spores that had developed oil globules

within and spores that had remained unaltered. When, however, the drops of spores were dried on the glasses not in the shade but in direct strong sunlight it was found that, while a few germinated after five hours of such treatment, after eight or more hours' exposure apparently not one survived.

In like manner perithecia that were mature but not yet discharged were carefully removed *in toto* to cover glasses, rapidly dried, and their resistance tested. When dried they shrank to small black hardened nodules, or depressed hemispheres, that adhered firmly to the glasses, but when water was added they resumed their former size, shape and consistency and soon discharged their spores. In some cases these perithecia retained their vitality even after drying in the shade for as much as four days, not only discharging living spores which germinated normally, but sending out an extensive growth of hyphae from their bases as well.

These experiments, although few and crude, do seem to indicate that distribution of the fungus to other similar pools could indeed be accomplished through the agency of spores or perithecia carried in mud or trash adhering to the feet of birds and other animals. Moreover, although no experimental evidence was secured, it seems highly probable that spores or perithecia taken in with food or water by such animals would survive passage through the alimentary canal and be able to start growth when voided into the water of favorable ponds. Consequently, even though the fungus, as far as is known at present, appears to be limited to this restricted locality it is to be expected that it will be found elsewhere.

THE IDENTITY AND POSSIBLE RELATIONSHIP OF THE FUNGUS

The peculiar features of structure and development that have been considered render the identity, relationship, and systematic position of this fungus of considerable interest.

The ostiolate, non-stromatic character of the perithecia, with their dark color and general habit, would seem to claim inclusion among the non-stromatic Sphaeriales, more especially in the family Sphaeriaceae, yet the texture, being somewhat cartilaginous or fleshy and certainly never hard and carbonaceous,

might argue for insertion in the Hypocreales in spite of the dark color. On the other hand the somewhat loosely woven texture of the upper portion of the perithecial wall, its collapse when the perithecium is dried, and, after spore discharge, its disintegration in some cases until only a fragmentary, irregular base remains, might be regarded as indicating affinities with the Hemisphaeriales even though the ostiole at first is circular and sharply defined, or indeed might suggest possible affiliations with the Discomycetes.

These rather contradictory features are not easily reconciled with one another and even the most distinctive characteristics of the peculiar structure of the spores and their resulting method of emergence, distribution and attachment, do not decisively point to any particular order, while the nice conformity in structure and behavior to the obligately aquatic mode of life shows no significant similarity to that of *Vibrissea* or other aquatic forms already known. Perhaps, therefore, it is not surprising that when material was sent for diagnosis to several mycologists more familiar with this group than the writer, they returned strikingly divergent opinions varying from the Perisporiales, through the Dothidiales, Sphaeriales and Hemisphaeriales of the Pyrenomycetes to even the Discomycetes proper or to orders of rather atypical forms intermediate between these. In view of this divergence of opinion, the writer is inclined to leave the question of the precise systematic position of this fungus to be settled in the future and will be very glad to supply material to anyone wishing to make comparative study to that end.

However, whatever its true position may prove to be, the fungus seems to be one as yet undescribed, with characteristics sufficiently distinctive to oppose including it in any recognized genus, rather to justify establishing it as new. In so doing the writer feels some diffidence since in this region of the Ascomycetes he admittedly lacks the experience of long-continued investigation and the extensive knowledge of pertinent yet less common literature which, after some years' study of the submersed Phycomycetes, he realizes only too well are necessary before one gains the fundamental familiarity that justifies such

a pronouncement. Yet in the standard taxonomic authorities, even after careful search, no description or mention of any such fungus has been found, nor has it been recognized as one already known by Dr. Thaxter, by Bruce Fink, by H. M. Fitzpatrick, and by various others, familiar with the group, to whom it has been shown; or by any of the mycologists with whom it was discussed when reported in 1923 at the Cincinnati meetings of the Mycological Section.

As it seems justifiable, therefore, to establish the fungus as new, the following description is given.

DIAGNOSIS

Loramyces [1] n. g.

Nutritive mycelium of fine, slender, inconspicuously septate, almost hyaline, branching hyphae, penetrating between and within the cells of the substratum, leading to a dark subiculum of closely interwoven, anastomosing, irregularly torulose hyphae, becoming compacted into a dense pseudotissue to form the small cushion-like base of the perithecium.

No conidial or other imperfect type of reproduction observed.

Perithecia occurring on the substratum either singly or associated, though never fused, in groups, at maturity flattened spheroidal to turbinate or onion-bulb-shaped, furnished at the apex with a circular ostiole surrounded by a circlet of pallid somewhat protrusive hairs, the whole body enclosed by a clear gelatinous investment, and of a fleshy rather than carbonaceous consistency.

Hymenium comprising hyaline paraphyses, and hyaline, approximately club-shaped asci, forming a slightly arched cushion practically filling the perithecial cavity and imbedded in a clear gelatinous matrix.

Spores hyaline, with somewhat asymmetrical, approximately spindle-shaped body, surrounded by a thick gelatinous capsule, and comprising two cells, the apical one with bluntly rounded point, the basal terminating in a filiform, slightly curved, hyaline, caudal appendage.

Loramyces juncicola n. sp.

Perithecia 1/2 to 2 mm. in diameter, either black throughout or black below, shading to brownish above, with pallid ostiole 20–50 μ in diameter.

[1] This generic name, an acknowledgment regrettably all too inadequate, is given in grateful appreciation of the one who for years has been to the writer a helpful critic and a loyal ally in this and in other work.

Paraphyses hyaline, sinuous, slender, filiform, 130 to 160 μ long by 1.5 to 2 μ in diameter, with rounded tip, isodiametric to slightly tapering, thin walled, with finely granular content, apparently continuous but with denser aggregations of granules at intervals giving the impression of pseudosepta.

Asci hyaline, slightly curved, approximately club shaped, 120 to 150 μ long by 8 to 11 μ in diameter, with thin wall, and rounded apex which at dehiscence opens by a small pore.

Spores hyaline, the two-celled body mostly from 17 to 22 μ in length and 4 to 6 μ in diameter, the caudal appendage usually 50 to 65 μ in length, that is, from $2\frac{1}{2}$ to 3 $\times$ the length of the body, rarely 40 to 80 μ, and from 0.5 μ to 0.75 μ in diameter. Spore body with thin wall and content finely granular with occasional denser aggregates and refractive guttulae, each cell uninucleate, the appendage thin walled and clear with occasional inconspicuous granular inclusions.

Gelatinous capsule surrounding the spore body, ellipsoidal to broadly fusiform, bluntly rounded at the point and tapering to the appendage at the base, naturally almost indistinguishably clear but on treatment with methylene blue or green showing zones and radiations of different densities.

Spores eight in an ascus arranged in a straight or slightly spiral series, the bodies overlapping part way, the appendages extending down beside the bodies of the next two or three spores below at discharge emerging one by one from the apical pore of the ascus and passing in the swelling expulsive material through the ostiole into the surrounding water, through which they sink slowly with the appendage uppermost, the apical cell, on touching suitable substratum, adhering by the gelatinous capsule and at once sending out a hypha of germination that gives rise to the mycelium.

Saprophytic on softened culms of *Juncus militaris* Bigelow, submerged from a few inches to two or three feet in a small freshwater pond at the eastern end of Nashawena of the Elizabeth Islands southwest of Woods Hole, Massachusetts, in July and August 1915 to 1927, and in a similar pond at French Watering Place on Naushon Island in August 1927.

Specimens and slides of the fungus have been deposited in the Farlow Herbarium of Harvard University.

POSSIBLE SIGNIFICANCE OR IMPORTANCE OF THE FUNGUS

Among the fungi, specialized aquatic forms such as this are of peculiar interest both because of their possible phylogenetic significance and because of the precision of their relation to the aquatic conditions under which they live.

With regard to the first point, if in the case of the fungi, as in the case of the phanerogams more commonly emphasized, our present land flora, according to the generally accepted view, has been derived from one living in the water, then the aquatic representatives of this group must be considered all the more significant and worthy of attention. Yet among the large numbers of fungi now known, relatively very few are aquatic, by far the most of these being included in some five orders of the Phycomycetes; while only exceedingly few, a very small number indeed, are found scattered through the main subgroups of the Ascomycetes. The aquatic Phycomycetes form a rather well-defined series with certain pronounced features which by many mycologists are considered significant indications that this series has been derived from ancestral Chlorophyceae. The aquatic Ascomycetes, however, do not as a whole seem to offer any such distinct indications of ancestral derivation, although the Laboulbeniales, which mycologically are a separate cosmos by themselves, present certain features on which is based the view deriving at least some of the present representatives of the class from the Rhodophyceae.

In the second place, the aquatic fungi are of interest because of their successful conformity in both morphological and physiological features to the peculiar submersed conditions of their environment. In this regard the submersed Phycomycetes are especially noteworthy, because of such features as their reproduction by zoöspores, but the aquatic Ascomycetes, in various features of structure and reproduction, and in various devices which accomplish distribution under aquatic conditions, also are of considerable interest.

If the fungus which has been described above is considered from the two aspects that have been mentioned it is seen to be without any apparent significance from the phylogenetic viewpoint. From the standpoint of conformity to aquatic conditions, however, it is decidedly worthy of attention. That the perithecia, developing quite submerged, remain until maturity impervious to the surrounding water which, if entering prematurely as through an injury, would cause a wholly useless expulsion of immature content, is one interesting feature. Chiefly, however,

it is the peculiarities in the structure of the spores and in their resulting method of emergence, of dissemination, of attachment and of germination, that distinguish the fungus as especially worthy of note. In these features there is a degree of specialization, a nicety of conformity to environmental conditions, and a success in survival, which, together with the fact that at present it is known only from the Elizabeth Islands, will, it is hoped, render this fungus one of more than passing interest to mycologists.

SUMMARY

The foregoing paper discusses a minute perithecial Ascomycete found growing on softened culms of *Juncus militaris* Bigelow, submerged from a few inches to two or three feet in a small freshwater pond on Nashawena Island, southwest of Woods Hole, Massachusetts, in July and August of several summers from 1915 to 1927 and in a similar pond at French Watering Place on Naushon Island in August 1927.

The morphology and reproduction of the fungus are considered, and the peculiarities in the structure, discharge, distribution, attachment and germination of the spores, in their conformity to the aquatic mode of life, are emphasized as especially noteworthy.

Certain aspects of the present limited occurrence of the organism on this restricted substratum in these small ponds are touched upon, and the possible means by which it might spread to other similar pools in the region are noted.

As the fungus, although quite distinctive, appears to be one as yet undescribed, it is established as a new genus *Loramyces* and species *L. juncicola;* the distinguishing characteristics and dimensions are given, and the possible relationships noted.

LABORATORIES OF CRYPTOGAMIC BOTANY,
HARVARD UNIVERSITY, CAMBRIDGE, MASS.

EXPLANATION OF PLATES 8 AND 9

With the exception of figure 1, these figures were drawn by means of a camera lucida and their approximate magnifications when reduced from the originals and printed here are given, scales with 10 μ divisions accompanying them also as an absolute measure. Material stained with picro-nigrosin and mounted in dilute glycerine was used for figures 7, 8 and 9, and material stained with acid methyl green and similarly mounted for figures 15 and 16,

while the others were drawn from untreated material in water, figures 2 and 13 being from sections cut free hand mounted thus.

1. General habit of the fruiting bodies of the fungus as they appear growing on a bit of the submerged and softened culm of *Juncus militaris*. Drawn on a 10 × magnified photograph made with a Zeiss Microplanar lens, the present magnification about 5 ×.

2. General appearance of the fruiting body as seen in vertical section through the ostiole showing the thin subiculum, the rounded base, the arched subhymenium supporting the bulging hymenial layer which is closely enveloped by the hyaline inner, and dark torulose outer perithecial walls running up to a circlet of hairs around the ostiole. × 90.

3. An ascus showing the common spiral arrangement of the spores and their appendages, the line of demarcation between the appressed gelatinous capsules being faintly visible. Spores 3 and 8, as if dying, are shrunken and irregular—a condition occasionally encountered. × 1000.

4. A common type of ascus with the eight spores lying in a relatively straight series. × 1000.

5. Portion of the base of an ascus showing the eighth spore still in place with its appendage bent in a double curve as it is forced down in the narrow space against the more densely granular basal substance. × 100.

6. Portion of the tip of an ascus with a spore caught in the terminal opening, the gelatinous envelope that is holding it not being visible in the water. × 1000.

7 and 8. Paraphyses showing their characteristic shape and structure and also the granular inclusions that are differentiated by staining. × 1000.

9 and 10. Typical spores showing the characteristic form and structure, the content in figure 10 untreated, in figure 9 stained slightly to show the single nucleus in each cell. × 1300.

11. Spore of the abnormal 3-celled type rarely encountered. × 1300.

12. A typical spore, germinating, as is customary, by sending out a hypha from the point of its apical cell. × 1300.

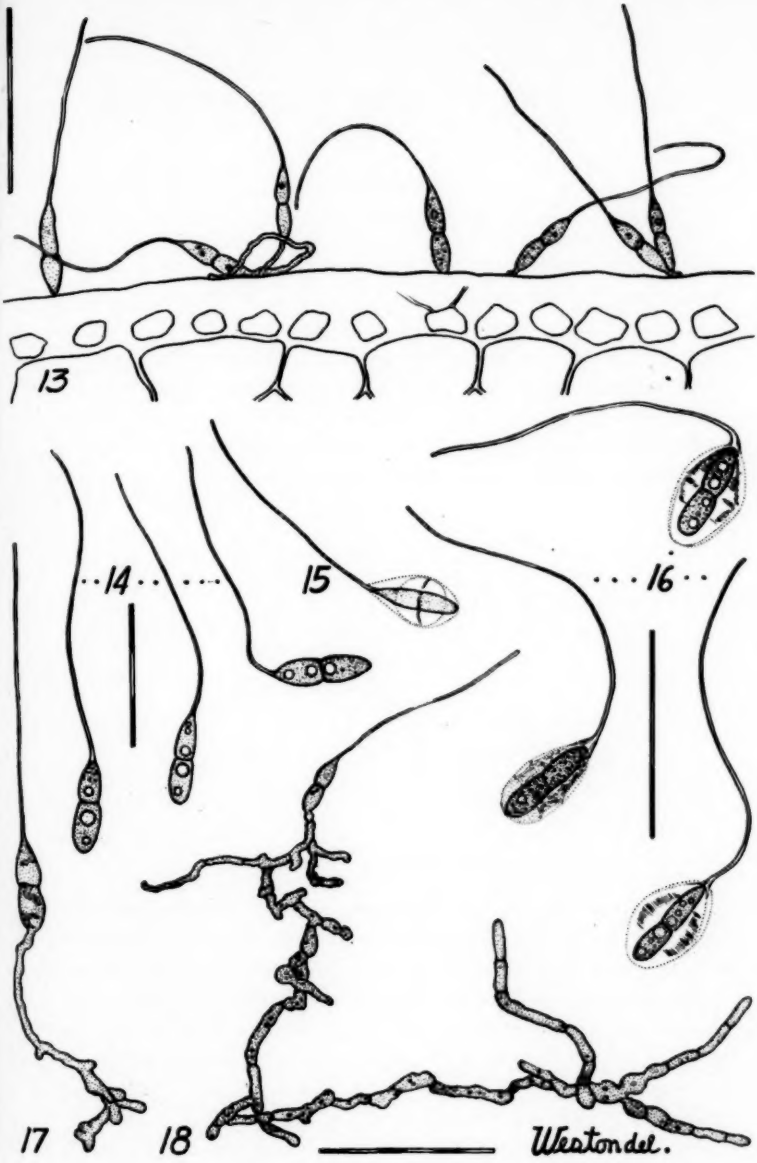
13. Portion of a cross-section cut from a *Juncus* culm that had been lying in a jar culture below discharging perithecia, showing spores that had sunk down, become attached and begun to germinate in the characteristic position. × 550.

14. Spores showing the guttulae that in some cases, especially after drying and then re-wetting, appear in the granular content. × 600.

15 and 16. Spores showing their gelatinous envelopes with the differentiated zones and striations that become visible after treatment with such stains as methyl green. 15 × 600, 16 × 800.

17. A germinating spore showing the germ tube from the apical cell just beginning to send out branches. × 600.

18. A later stage in germination showing the formation of an irregular, branched mycelium beginning. × 375.



LORAMYCES

ANOTHER FERN RUST OF THE GENUS DESMELLA

J. C. Arthur

(With 1 Text Figure)

The rusts occurring on the ferns are especially interesting due to the ancestry of the hosts and a seemingly corresponding ancestry of the accompanying rusts.

The genus *Desmella*, founded by Sydow on *Uredo Aneimiae* P. Henn., is particularly noteworthy, as it represents a very primitive form of the Pucciniaceae. Four species were recognized by Sydow (Ann. Myc. **16**: 241. 1918) at the time of establishing the genus, and one other tentatively, but the writer considers

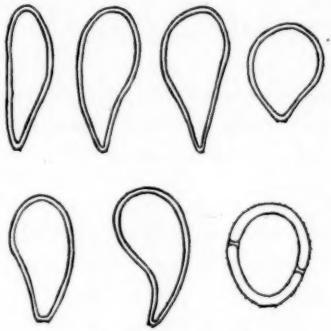


Fig. 1. *Desmella obovata*

that they are all reducible to two species: *D. mbatobiensis* (Speg.) Sydow, of which *D. Aneimiae* is a synonym, founded on a later name, and *D. superficialis* (Speg.) Sydow, with a number of synonyms. *D. mbatobiensis* is only known from South America. *D. superficialis* appears to be the most common and widely distributed member of the genus. It occurs on many genera of ferns.

Another form can now be placed in the genus *Desmella*, although only the uredinia have been seen. It is well separated

from the others by the striking shape of the urediniospores and the minuteness of their echinulation.

Desmella obovata sp. nov. Uredinia amphigenous, scattered, round, small, at first bullate and covered by the epidermis, finally pulverulent, yellow fading to white; urediniospores wedge-shape, obovate or obovate-ellipsoid, rounded above and more or less pointed below, 13–18 by 28–38 μ; wall colorless, 1–2 μ thick, very minutely and evenly echinulate, appearing smooth when wet, pores obscure.

On *Elaphoglossum latifolium* (Swartz) J. Sm., lower eastern ridge of Mossman's Peak, Jamaica, alt. 1600–1700 m., June 30, 1926, *William R. Maxon 9680* (type); same, upper eastern ridge and summit of Mossman's Peak, Jamaica, alt. 1700–1925 m., July 2, 1926, *William R. Maxon* on *E. latifolium* (Swartz) J. Sm. *9796* and *E. chartaceum* (Baker) C. Chr. *9735*.

The collections were made in the wet forest, a habitat not congenial to most rusts. A few spores were seen with evenly thick walls, about 3 μ, in which two opposite pores could be detected, which may be a resting form.

The writer feels especially grateful to Mr. Maxon, not only for the opportunity to study the material cited, but for other collections of fern rusts detected from time to time while examining his extensive collections of ferns.

PURDUE UNIVERSITY,
LAFAYETTE, IND.

THE UREDINIA OF MELAMPSORA AND COLEOSPORIUM

E. H. Moss

(With 2 Text Figures)

A feature of considerable interest in connection with the phylogeny of the rusts is the uredinial peridium of *Melampsora*. The presence of a peridium in the uredinia of certain species of this genus was pointed out as long ago as 1899 by Klebahn (**1**) and more recently by Kursanov (**2**), by Hiratsuka (**3**) and by the writer (**4**). Whether this peridium is to be regarded as homologous with the uredinial peridium of the Pucciniastreae is an interesting question upon which fairly conclusive evidence is presented below.

Two species of *Melampsora*, namely, *M. confluens* (Pers.) Jackson on *Salix lutea*, and *M. Lini* (Ehrenb.) Lév. on *Linum usitatissimum*, have been examined. Young uredinia of the former species were carefully fixed in the field. In passing, it may be mentioned that many of the older pustules in the collections of *M. confluens* were parasitized by *Darluca Filum*. Uredinia of *M. Lini* were obtained from greenhouse cultures of this rust made by Dr. A. W. Henry. Two fixing fluids, medium chromacetic acid and formalin acetic alcohol, were used, and the preparations were stained with safranin and light green.

The mode of development of the uredinia of these species of *Melampsora* is essentially the same as has been described for *M. Medusae* (**4**). Vertical hyphae arise in palisade fashion beneath the epidermis and divide each into three enlarged cells, viz., peridial, intercalary and basal cells. The latter give rise by "budding" to spore-initials, while the intercalary cells are soon disorganized by the expansion of the spore-initials (Fig. 1). The peridial cells are commonly evanescent also, although they may persist beneath portions of the epidermis that have not been destroyed by the opening of the pustule.

A critical examination of young uredinia was made with a view to determining the mode of origin of intercalary and peridial cells. Each vertical hypha in the young sorus divides transversely to form two cells, the lower of which is a sporogenous cell, while the terminal divides to form peridial and intercalary cells. Numerous cases of conjugate nuclear division associated with the formation of peridial and intercalary cells provide conclusive evidence that these cells are sisters.

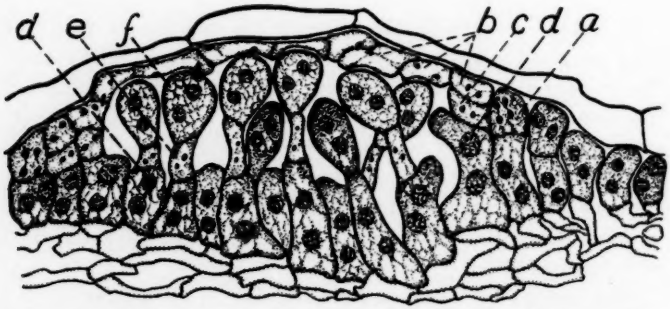


FIG. 1. Median vertical section showing early stage in development of uredinium of *Melampsora Lini:* (a) mother-cell of a peridial and an intercalary cell; (b) peridial cells; (c) intercalary cell; (d) sporogenous cell; (e) spore-stalk; (f) spore.

Therefore, the peridium of *Melampsora* may be regarded as homologous with the uredinial peridia of the Pucciniastreae (**5**) and *Cronartium Comandrae* (**4**). The writer can not agree with Kursanov's conclusion (**2**) that intercalary cells are absent in the uredinium of *Melampsora*. Also, there appears to be little evidence in support of Kursanov's suggestion that *Melampsora* is the most primitive of the Melampsoraceae.

The uredinium of *Melampsora Lini* is characterized by elongated sporogenous and stalk-cells (FIG. 1). Each stalk consists of a single cell and is not made up of two or three cells as has been described and figured by Fromme (**6**). Evidently the basal sporogenous cell was interpreted by Fromme as constituting part of the spore-stalk.

The uredinium of *Coleosporium* is said to be without a peridium, but, since a peridium occurs in the corresponding sorus of

Melampsoropsis, likewise a rust with catenulate urediniospores, a critical examination of young sori of *Coleosporium* seemed desirable.

Uredinia of *Coleosporium Solidaginis* Thüm, collected on *Solidago rugosa* Mill, were carefully fixed, embedded, sectioned and stained in the usual way. An examination of many preparations of uredinia in various early stages of development has revealed no sign of a peridium. As shown in Fig. 2, the terminal

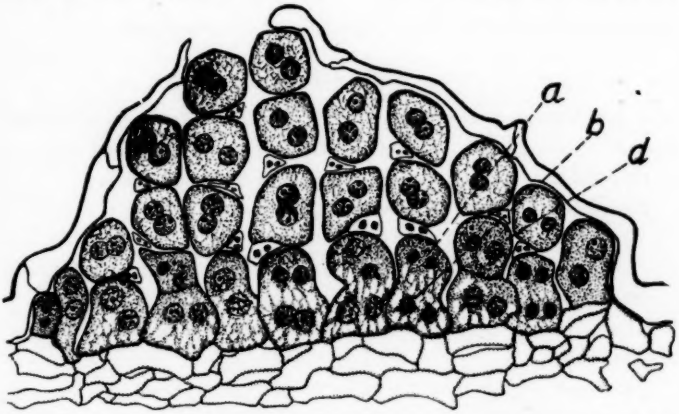


FIG. 2. A young uredinium of *Coleosporium Solidaginis* in median vertical section: (a) spore-initial 'bud'; (b) sporogenous cell; (d) spore-initial.

cells of the columns that arise in the sorus are differentiated as spores.

It is well known that the basal cells in the uredinium of *Coleosporium* give rise by basipetal abstriction to vertical rows of spores, the latter alternating with narrow intercalary cells. Spore-initials are cut off in succession from each basal cell, the spore-initial then dividing to form a spore and intercalary cell. It is a generally accepted view that the intercalary cell of *Coleosporium* is homologous with the stalk-cell of rusts whose urediniospores arise singly (not in chains). In *C. Solidaginis* the spore-initial abstricts a small intercalary or stalk cell, usually at one corner of the lower side, and at about the same time becomes detached from the new "bud" formed by the basal

cell. At an early stage the intercalary cell separates from the spore and soon disorganizes. These features are illustrated in Fig. 2 and also by Christman (**7**). This method of spore formation is in reality quite similar to that which characterizes those rusts whose urediniospores arise singly from the basal cells. In both types the spore-initials originate as a succession of buds from the basal cell, the essential difference being that in *Coleosporium* each new spore-initial buds out almost directly below the one which preceded it, whereas in the other type new spore-initials arise by lateral budding of the basal cell.

SUMMARY

A peridium is present in the uredinia of *Melampsora confluens* and *M. Lini*, as well as in *M. Medusae* already described (**4**).

Intercalary (disjunctive) cells occur in all three species.

Peridial and intercalary cells are sister cells.

The peridium of *Melampsora* may be regarded as homologous with the uredinial peridia of the Pucciniastreae (**5**) and *Cronartium Comandrae* (**4**).

There is no peridium in the uredinium of *Coleosporium Solidaginis*.

Attention is drawn to the close similarity between the method of spore formation by *C. Solidaginis* and by those rusts whose urediniospores occur singly; in both types the spore-initials arise as a succession of buds from the basal cells.

Gratitude is expressed to Professor J. C. Arthur for determining the species of *Melampsora* on *Salix* and to Dr. A. W. Henry for supplying excellent material of *M. Lini* from cultures of this rust.

BOTANICAL LABORATORIES,
UNIVERSITY OF ALBERTA, CANADA

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USTILAGO ECHINATA SCHROET.

D. M. BENEDICT

(WITH 1 TEXT FIGURE)

While collecting in an unpastured meadow three miles south of Chelsea, Mich., on July 19, 1927, and again on August 19, 1927, the grass, *Phalaris arundinacea* L., which is the dominant grass in this area, was found to be heavily infected with a smut identified as *Ustilago echinata* Schroet.; the identification was verified by G. P. Clinton. Its appearance was striking and

FIG. 1. Inflorescence of *Phalaris arundinacea* L. distorted by *Ustilago echinata* Schroet.

quite different from the concept one gets from the descriptions in the available literature or from the exsiccati distributed in herbaria. Culms of infected plants usually fail to develop the inflorescence which remains partially rolled in the leaf of the uppermost node with only the middle portion protruding. Increasing in length in its imprisoned situation, the inflorescence is forced to fold back upon itself and therefore pushes out laterally. The whole appears somewhat swollen, greatly twisted and

contorted, and directed more or less at right angles to the axis of the culm. The blade and leaf sheath directly inclosing the inflorescence are frequently wrinkled in longitudinally compressed folds. The characteristic smut sori appear on the hypertrophied portion and also on the leaf sheath and blade which partly inclose it. On the latter date mentioned above, the leaf blades on the lower part of the culms exhibited the characteristic sori as described for this species by Clinton in the North American Flora **7**: 1, 1910; Saccardo, Sylloge Fungorum **7**: 470; and Winter in Rab. Krypt.-Fl. **1**: 96; and as distributed in the following exsiccati: Sydow, Mycotheca Germanica no. *668*, and Brenckle, Fungi Dakotenses no. *595*. Descriptions of this species, as given in the various references cited above, make no mention of the infected and distorted inflorescence. Dr. Clinton (l.c.) gives *Ustilago Vestergreni* Sacc. & Sydow as synonymous with *Ustilago echinata* Schroet. The description of *Ustilago Vestergreni* in Sylloge Fungorum **14**: 413, 1899, states that: "Soris atrobrunneis inflorescentias nondum evolutas . . . occupantibus." The condition of the inflorescence as I have described it has been found to be a uniform and general one throughout this area where several hundred specimens were collected. It may well be suspected that this is the normal appearance when infections are caused by this fungus. The manner in which the infected inflorescence pushes out of the sheath suggests that possibly the disease may be systemic.

Inquiries made at twelve of the larger herbaria of the United States revealed no specimens showing a distorted inflorescence. This may be due to the fact that the flatly pressed leaf blades make a neater packet than the swollen and clumsy flower heads. The same inquiry also shows that American collections are reported from very few localities. Places from which specimens have been collected and distributed are Bingen, state of Washington, and Northville, South Dakota. Clinton (l.c.) reports its occurrence in Nebraska and Washington. This Michigan collection would seem to extend the known range of *Ustilago echinata* Schroet. considerably, possibly being the first record east of the Mississippi River.

UNIVERSITY OF MICHIGAN,
ANN ARBOR, MICH.

STUDIES OF THE SEDGE RUST, PUCCINIA CARICIS-SHEPHERDIAE

W. P. Fraser and G. A. Ledingham

(With Plate 10)

An *Aecidium* on *Lepargyraea canadensis* (L.) Greene [*Shepherdia canadensis* (L.) Nutt.] collected at Buffalo, N. Y., was described as *Aecidium Allenii* by Clinton (Ann. Rept. N. Y. State Museum **24**: 93. 1872). Davis (Trans. Wis. Acad. Sci. **21**: 299. 1924) described culture experiments, from which he concluded that *Aecidium Allenii* on *Lepargyraea canadensis* was connected with telia on *Carex eburnea* Boott. He described the rust as *Puccinia Caricis-Shepherdiae*. Arthur (North Am. Flora **7**: 785) places this rust under *Dicaeoma Allenii* and records aecia on *Lepargyraea canadensis* and *L. argentea* (Nutt.) Greene and telia on *Carex viridula* Michx. and *Carex eburnea*. The senior author (Mycologia **17**: 82. 1925) reported unsuccessful inoculations of a number of grasses with the aeciospores of *Aecidium Allenii* Clinton from *Lepargyraea argentea*.

An *Aecidium* of the type of *Aecidium Allenii* was found to be very common in Northern Saskatchewan on species of the family Elaeagnaceae. A field study was made to determine its telial relationship. This study suggested the connection of the aecia on *Elaeagnus commutata* with telia on *Carex lanuginosa* Michx. In 1925 inoculations were made in the greenhouse on *Carex lanuginosa* with aeciospores collected at Saskatoon on *Elaeagnus commutata*. Infection followed with a marked development of telia.

In 1926 inoculations were made on *Elaeagnus commutata*, *E. angustifolia*, *Lepargyraea canadensis* and *L. argentea* with germinating teliospores from *Carex lanuginosa* collected at Saskatoon. Pycnia developed abundantly on all the shrubs and aecia on all except on *L. canadensis*. The experiments were repeated with like results. The plants of *L. canadensis* were in a flourishing condition, so the failure to develop aecia was not due

to lack of vigor of the host. Aecia were collected on all of these shrubs at Saskatoon and inoculations were made on *Carex lanuginosa*. Uredinia and telia developed in every case, except when aecia from *L. canadensis* were used. Then no infection followed.

The inoculations were continued in 1927 using teliospores collected at Saskatoon on *Carex lanuginosa* and *C. aquatilis* with the same results as in 1926. Telia from *C. aquatilis* Wahl. collected at North Battleford, about one hundred miles distant from Saskatoon, gave infection on all shrubs used in 1926 including *L. canadensis*, with abundant development of pycnia and aecia. The experiments were repeated using teliospores from *Carex lanuginosa* collected at North Battleford and pycnia and aecia developed abundantly.

Teliospores on *Carex atherodes* Spreng. collected at Saskatoon infected *Elaeagnus commutata* with the development of uredinia and telia. Aeciospores from *Elaeagnus commutata* also gave slight infection on *Carex Sprengelii* with sparing development of telia.

The telial stage of this rust was found to be very common in Northern Saskatchewan on *Carex lanuginosa* and *Carex aquatilis*. A few collections were made on *Carex atherodes*. The uredinial stage was only sparingly developed in the greenhouse cultures and also in the field collections. The aecial stage is also very common on the native shrubs *Elaeagnus commutata*, *Lepargyraea canadensis* and *L. argentea*, and on the Russian Olive (*Elaeagnus angustifolia*), an introduced shrub frequently planted in hedges. In wet seasons hedges of this plant are partially defoliated. From these experiments *Lepargyraea canadensis* does not seem as congenial a host as the other shrubs. The different results obtained from inoculations with teliospores obtained at Saskatoon and North Battleford may indicate that there are biologic forms with different reactions on *L. canadensis*.

A morphological study was made of the various spore forms. The aecia usually occupy large areas of the leaf: the pycnia are prominent and usually arranged in a stellate manner. These characters easily distinguish them from *Puccinia coronata*, which also occurs on some of these shrubs. There was a close agreement

with Arthur's description in the North American Flora, except that the aeciospores averaged a few microns larger and pycnia were always present in our field collections and in cultures and usually rather conspicuous. Arthur in the N. A. Fl. states the pycnia are "few or none." Arthur (Bull. Torrey Club **47**: 477. 1920) described an *Aecidium* on *E. angustifolia* as *Aecidium arctoum*. From this study it seems this form should be assigned to *Puccinia Caricis-Shepherdiae*.

Through the courtesy of Mr. House of the New York State Museum, we were able to examine part of the type of *Aecidium Allenii*. The aecia were similar to those studied and here assigned to *Puccinia Caricis-Shepherdiae*. Collections made on *Lepargyraea canadensis* and *Carex eburnea* by Dr. J. J. Davis in Wisconsin, and by Prof. J. Dearness in Ontario, were also examined and found to agree with the Saskatchewan material.

Collections of aecia on *Elaeagnus commutata* were also made at Morrin, Alberta, and in Northern and Southern Manitoba by Mr. E. Criddle on *Lepargyraea canadensis*, so that it is probable this rust is widely distributed in the Prairie Provinces of Canada.

SUMMARY

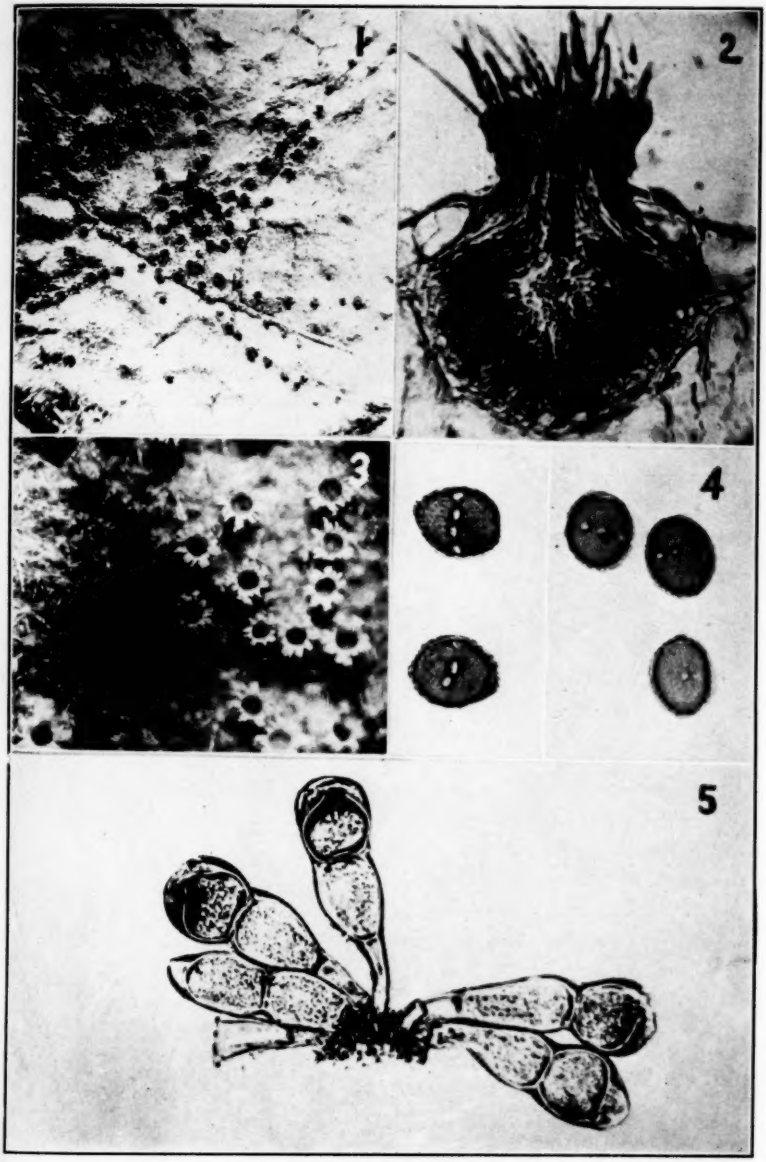
Inoculations with teliospores of *P. Caricis-Shepherdiae* on *Carex lanuginosa* and *Carex aquatilis* produced pycnia and aecia on *Elaeagnus commutata*, *E. angustifolia*, *Lepargyraea argentea* and *L. canadensis*.

Inoculations with aeciospores from *Elaeagnus commutata*, *E. angustifolia*, *Lepargyraea argentea* and *L. canadensis* produced uredinia and telia on *Carex lanuginosa* and *Carex aquatilis*.

A few collections of teliospores of *P. Caricis-Shepherdiae* on *Carex lanuginosa* produced pycnia on *L. canadensis* but failed to produce aecia, though producing normal infection in the other shrubs named in the preceding paragraph. This may indicate biologic forms.

Aecidium arctoum on *Elaeagnus angustifolia* and *Aecidium Allenii* on *Elaeagnus commutata*, *Lepargyraea canadensis* and *L. argentea* are from these studies assigned to *Puccinia Caricis-Shepherdiae*.

The writers wish to acknowledge the aid of Mrs. Bernhard



PUCCINIA CARICIS-SHEPHERDIAE

Nebel (*née* Mabel L. Ruttle) in making field observations and in culture work in the greenhouse. They also wish to gratefully acknowledge the courtesy of Mr. House of the New York State Museum, Dr. J. J. Davis and Dr. Dearness for supplying material as mentioned in the paper.

UNIVERSITY OF SASKATCHEWAN,
SASKATOON, CANADA.

EXPLANATION OF PLATE 10

Fig. 1. Pycnia on leaf of *Lepargyraea canadensis* showing stellate arrangement (× 60).

Fig. 2. Section through pycnium on leaf of *Lepargyraea canadensis* (× 275).

Fig. 3. Aecia on leaf of *Elaeagnus angustifolia* (× 25).

Fig. 4. Urediniospores showing equatorial arrangement of germ pores, collected on *Carex aquatilis* (× 375).

Fig. 5. Teliospores on *Carex lanuginosa* (× 500).

A NOTE ON THE OCCURRENCE OF TWO ROTIFER-CAPTURING PHYCOMYCETES

F. K. Sparrow, Jr.

(With 1 Text Figure)

Although many fungi are known to parasitize various animals, the type of parasitism that involves the capturing and killing of actively moving prey of disproportionately large bulk by minute fungi which then consume the victim seems, as far as at present known, to be restricted to a few forms. The two striking examples of this mode of life are *Zoophagus insidians* Som. and *Sommerstorffia spinosa* Arn., filamentous aquatic Phycomycetes, which have been described in recent years as capturing members of the Rotiferae. Apparently, these two fungi are somewhat limited in their distribution, *Zoophagus* having been heretofore reported from seven localities situated in Styria, Bulgaria, Germany, France, Croatia and the Eastern United States, while *Sommerstorffia*, up to the present writing, has never been reported, as far as could be ascertained, since its discovery in Bulgaria.

The writer has had the good fortune during the past year to find and to observe these two interesting fungi and, in view of the fact that their parasitism is of such an unusual type and that references to them in the literature are so few, the presentation of this brief note concerning them seems justifiable.

Sommerstorffia spinosa Arn. was observed by the writer in March, 1927, while examining a laboratory culture of *Rhizoclonium* sp. (?), collected in a small pond in Fresh Pond Parkway, Cambridge, Mass., October 20, 1926, capturing members of the genus *Monostyla*. The American material, in general, resembled closely the description of Arnaudow (**2**) and, as we have only this author's account of the organism, it seems desirable to include here some of the main features of the fungus as shown by this material.

The primary mycelium of the fungus, in this American material, was not extensively developed, being limited to three to

five short, slightly tapering branches which exhibited a tendency to encircle the algal filament in a manner suggesting an epiphytic association with the *Rhizoclonium* (FIG. 1). The hyphae were, with the exception of their tips, practically isodiametric, non-septate and from 4–6 μ in diameter. Except where attached for a time to the body of the rotifer, the tip of each hypha was constricted and elongated to form a spike-like structure of varying length (FIG. 1). It is by means of these structures that the rotifers are captured, for, according to Arnaudow, their tips

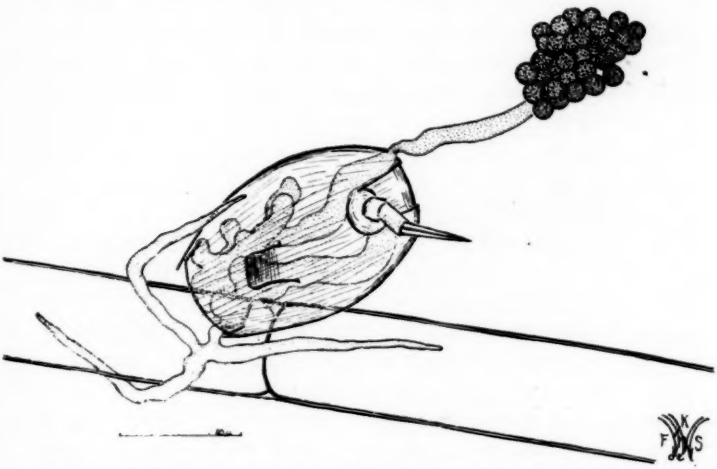


FIG. 1. Habit drawing of *Sommerstorffia spinosa* Arn. epiphytic upon a portion of a filament of *Rhizoclonium* sp. (?), showing the primary mycelium clasping the alga and bearing projecting attenuated points, an attached rotifer within which the contorted feeding hyphae are visible, and an evacuation tube emerging from the posterior region of the animal and bearing at its apex an irregular mass of encysted zoospores. The content of the alga is not shown but was normal. The drawing was made with the aid of the camera lucida from material mounted in glycerine and eosine. × 500.

excrete a sticky, mucilaginous substance to which the passing rotifer becomes stuck, usually in the region of the mouth. Once captured in this manner, the animal, in spite of all its efforts to escape, is held fast, dies, and its body is soon invaded by the mycelium of the fungus, which, growing in through the mouth, completely fills the soft interior and consumes all but the chitinous

outer shell. The American material showed several cases of rotifers captured and devoured in this manner.

The mycelium which develops within the rotifer presents a swollen, distorted and sacular appearance (FIG. 1) with hyphae from 5–8 μ in diameter, which have a few lateral branches of varying length. These branches, in contrast to the primary hyphae, do not produce specialized tips and have no differentiation of their end walls.

Non-sexual reproduction in *Sommerstorffia* is by means of zoöspores and in the American material this phase was well developed. Preceding their formation there developed from the mycelium within the rotifer an elongate, isodiametric evacuation tube which extended, after a marked constriction of its diameter, from the posterior region of the shell about 54 μ out into the water (FIG. 1). Although the writer was only fortunate enough to observe the discharge of the last zoöspore from the mouth of the sporangium, the process was apparently the same as that described by Arnaudow. After emergence, the zoöspores rounded off, encysted, and formed an irregular, motionless group at the apex of the sporangium (FIG. 1). The encysted zoöspores were 7.2 μ in diameter, which was less than the 10 μ described by Arnaudow, a discrepancy which possibly may have been due in part to shrinkage in glycerine before measurements were taken. Emergence of a biciliate zoöspore from each of these cysts was observed by Arnaudow and presumably would occur here also, although it was not seen by the writer.

Reproduction by means of oögonia and oöspores was described by Arnaudow but was not found in the present material. According to Arnaudow the oögonia were characterized by the possession of blunt, irregular projections on their walls and, as no antheridia were observed, he concluded that the fungus was apandrous. The oögonium when mature contained one smooth walled oöspore which was described as up to 22 μ in diameter. Germination of the oöspore was not observed. No further points of importance in the life history were described by Arnaudow nor did the scanty material of the writer afford such an opportunity. Although no oögonia or oöspores were observed by the author, the very characteristic vegetative condition of

the fungus, as well as its non-sexual reproductive structures, identified the organism with certainty.

Zoophagus insidians Som., the second of these rotifer-capturing fungi, was found by the writer in March, 1928, in a laboratory culture containing *Nitella* sp. (?) and several members of the Chlorophyceae, collected in September, 1927, by Mr. Hollis Webster in Maine.

This fungus is characterized at once by the occurrence along the entire length of its mycelium of short, blunt, peg-like lateral branches of varying length, which arise at right angles to the main filament. The mycelium is non-septate, isodiametric and, in contrast to *Sommerstorffia*, is extensively developed. Although it ramifies freely throughout the algal filaments in the culture, no definite epiphytic relationship with these organisms, such as occurred in *Sommerstorffia*, has been noticed. The method of capturing the rotifer, however, is similar to that previously described for *Sommerstorffia*, the tips of the peg-like lateral branches exuding a sticky substance which holds the rotifer fast until penetration by the hypha is effected.

Arnaudow (**1**) (**3**), who has investigated in detail the life history of *Zoophagus*, found that slender, fusiform gemmae were produced by the mycelium, which, upon germination, gave rise to the typical vegetative mycelium. The non-sexual reproduction of *Zoophagus*, as described by this investigator, is similar to that found among the members of the section *Aphragmium* of the genus *Pythium* since, as in this group of fungi, the undifferentiated protoplasm is discharged from a filamentous sporangium into a vesicle, situated at the apex of this former structure, and is there cleaved into zoöspores. The zoöspores in *Zoophagus* were found to be diplanetic. It was further observed that the fungus was heterothallic and that the anastomosing of a plus and minus mycelium was necessary for the production of sexual organs. No measurements of the oögonia, antheridia, or mature oöspores were given by Arnaudow. Not all these details were observed in the American material, but enough to make the identity of the fungus absolutely certain.

From the standpoint of their aquatic habitat, in a surface relation to algae, their general morphology and life history and

especially their mode of parasitism, these two forms seem intimately related. But when their broader relationships are considered, it is obvious that they show general similarities to two different groups of fungi.

Sommerstorffia is clearly a member of the Saprolegniales and of this group it more nearly approaches the genus *Aphanomyces*. The irregular protuberances on the oögonium wall are similar to those found in *Aphanomyces stellatus* deBary, while in its habitat it recalls *Aphanomyces phycophilus* deBary, a form thus far found only as a parasite of *Spirogyra* and *Zygnema*. The swollen and distorted intramatrical mycelium, so characteristic a feature of *Sommerstorffia*, is simulated in a closely related form, *Aphanomycopsis*, a genus recently described by Scherffel (**6**) as parasitic on several members of the Diatomeae. It differs from all of these, however, in its mode of parasitism and apandrous oöspores. The writer's conclusions as to the position of *Sommerstorffia* among the Phycomycetes are in entire agreement with those of Arnaudow, who placed the fungus in the Saprolegniaceae near the genus *Aphanomyces*.

Zoophagus, on the other hand, seems to be closely allied to the group of aquatic and semi-aquatic fungi placed in the section *Aphragmium* of the genus *Pythium*. The production of gemmae, regularly found in *Zoophagus*, has not, however, been reported as occurring in any members of the Aphragmia found thus far. The occurrence in *Zoophagus*, which possesses sexual and non-sexual reproductive organs similar to those of *Pythium*, of a typical saprolegniaceous structure, the gemma, has suggested to Arnaudow the possibility that *Zoophagus* may be a connecting link between these two groups of organisms. Most of the species of the Aphragmia, however, have been scarcely more than described and, until they have been subjected to conditions similar to those of *Zoophagus*, we cannot be sure that they also will not produce gemmae. It is further possible that in the future forms will be found which will more nearly bridge the wide differences in the process of zoöspore formation between the two orders.

As presented in the literature, both *Sommerstorffia* and *Zoophagus* appear to be rather limited in their distribution.

Sommerstorffia was first found near the village of Dragitschewo in the vicinity of Sophia, Bulgaria, in 1923 by N. Arnaudow (**2**). It was there observed capturing members of the genus *Monostyla* and was described by its discoverer as "zwar epiphytisch auf *Cladophora*." Up to the present time, so far as the writer has been able to determine, the fungus has not since been observed.

Judging from the frequency of its occurrence in the literature, *Zoophagus* is apparently more common than *Sommerstorffia*. The former fungus was discovered and described in 1911 by H. Sommerstorff (**7**), who found it in a culture of *Cladophora* and *Spirogyra* collected in the vicinity of Gratweni in Styria. It was next reported by Arnaudow (**1**), who found it in 1913 among filaments of *Oedogonium* and *Bulbochaete*, collected in the environs of Sophia, Bulgaria, and again in 1925 near Munich, Germany (**3**). *Zoophagus* was further reported from France (**5**) (1920) by Mirande and from Croatia (**4**) (1922) by Gicklhorn. The only report of the fungus from the United States appears to be that of Weston (1923), who, in a short paper delivered before the mycological section of the Botanical Society of America at the Cincinnati meeting in 1923, described the occurrence of the fungus in a culture of algae maintained for some years in the cryptogamic laboratories of Harvard University. Slides of this material, as well as others of the same fungus collected by Professor Weston at Great Barrington, Massachusetts, have been examined by the writer and have been found to agree in every respect with the Maine specimens.

It seems evident that these exceedingly unusual forms will, upon intensive search, be found to be much more widely distributed than has hitherto been supposed and it is hoped in the future that further investigation will add much to our knowledge of this group of rotifer-capturing parasites.

In conclusion, the writer wishes to thank Professor Weston for his kind aid and criticism in the preparation of this note and for his assistance in making the plate.

CRYPTOGAMIC LABORATORIES OF HARVARD UNIVERSITY

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CONTRIBUTION TO OUR KNOWLEDGE OF OREGON FUNGI—III [1]

S. M. Zeller

(With 3 Text Figures)

BASIDIOMYCETES

Family 1. Uredinaceae

1. Gymnoconia interstitialis (Schl.) Lag.

On Kittatinny blackberry, Salem. Infrequent. May. No. *6927*.

Family 2. Clavariaceae

2. Clavaria rugosa Bulliard.

In wood lot, Corvallis. December. Frequent. No. *2076*.

3. Clavaria myceliosa Peck.

In coniferous woods, Corvallis. October to November. Frequent. No. *2032*.

4. Clavaria formosa Fries.

In coniferous and mixed woods, Corvallis and Blue River. October to November. Nos. *2158*, *2407*.

Branches wrinkled, blunt, dichotomous above, light ochraceous-buff to light ochraceous-salmon, turning deep vinaceous in all parts when bruised.

5. **Clavaria occidentalis** n. sp.

Fructifications simple or seldom once-forked, single or caespitose, narrowly clavate, often flattened with longitudinal furrows on larger plants, up to 15 cm. long and 4 to 8 mm. broad, Rood's brown when fresh, drying wood brown, concolorous throughout except whitish at base in larger plants; odor pleasant, taste slightly acrid; flesh white; internal structure in central portion hollow to stuffed with meshy strands of filaments, gradually passing to a subhymenial layer of soft pseudoparenchyma; basidia subcylindrical to clavate, 55–74 × 7–9 μ, 2–4-spored; spores ellipsoidal to inequilateral, hyaline, granular, one-guttulate, asperu-

[1] Continuation of mycological notes. Mycologia **19**: 130. 1927.

late, 6–8 × 3–4 μ. Spore print white. Cystidia few, hyaline, conic above hymenium, projecting 37–52 μ, sometimes encrusted and gloeocystidia-like. (FIG. 1.)

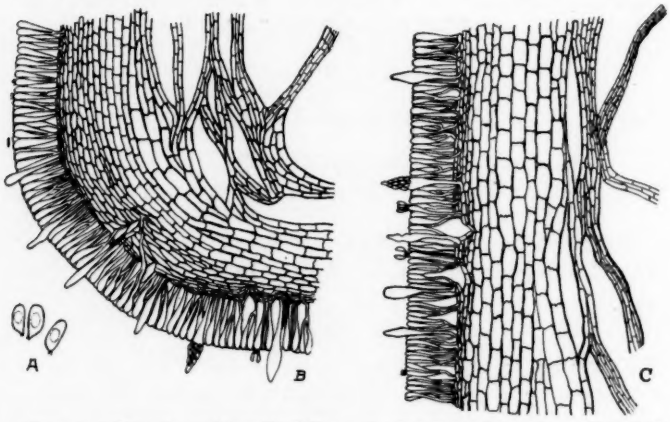

FIG. 1. *Clavaria occidentalis* Zeller. A. Ascospores. × 600. B and C, respectively, cross and longitudinal sections of hymenium and underlying tissue. × 100.

On humus among mosses, Waldport. December. (Type in Zeller Herb., *7185*, and in Ore. Agr. Coll. Herb., *4935*.)

Clavaria occidentalis bears a close relationship with *C. incarnata* Weinm., *C. purpurea* Fr. and *C. rosea* Fr. from all of which it differs in the slightly rough spores and size of basidia.

Family 3. THELEPHORACEAE

6. CRATERELLUS CORNUCOPIOIDES (L.) Pers.

Among mosses and *Rhus diversiloba*, Corvallis. November. No. *7146*.

This collection extends the reported range of this species from Missouri to the Pacific Coast.

7. STEREUM CHAILLETII Pers.

On a coniferous wood, Devil's Lake, Tillamook County, and Corvallis. Infrequent. July and November. Collected by Epling Nos. *167* and *765*.

8. STEREUM CINERASCENS (Schw.) Massee.

On *Ulmus*, Corvallis. October. Infrequent. No. *6881*.

9. STEREUM ERUMPENS Burt.

On apple, Corvallis. March. Frequent. No. *2087*.

Previously reported from Grants Pass in this State. This is the most common Thelephore on pomaceous fruit trees in the Pacific Northwest.

10. STEREUM MURRAYI (Berk. & Curt.) Burt.

On oak, Hood River. April. Infrequent. No. *6908*.

First report of this species from Oregon.

11. STEREUM RUGISPORUM (Ellis & Ev.) Burt.

On *Picea*, Crater Lake National Park and Waterville.

Collected by Epling and Shoret. Epling Nos. *641, 835*.

12. STEREUM SANGUINOLENTUM Alb. & Schw.

On *Pseudotsuga*, Corvallis. October. Infrequent. No. *6880*.

13. STEREUM SUBPILEATUM Berk. & Curt.

On *Quercus garyana*, Corvallis. Infrequent. October. No. *6882*.

This perennial *Stereum* has been previously reported from Jasper, Texas, in the Southwest, but its occurrence in Oregon greatly extends its known western range in the Northern United States.

14. CORTICIUM CENTRIFUGUM Lév.

On *Pseudotsuga taxifolia*, Corvallis. September. Frequent. No. *2066*.

15. CORTICIUM EVOLVENS Fries.

On willow, Corvallis. Infrequent. November. Collected by Epling. No. *719*.

16. CORTICIUM LIVIDUM Pers.

On decorticated log in mixed woods. Philomath. November. No. *2159*.

17. CYPHELLA FASCICULATA (Schw.) Berk. & Curt.

On *Alnus* twigs, Corvallis. November. Epling No. *432*. Zeller No. *2623*.

This is the first report of this species west of Wisconsin.

18. SOLENIA ANOMALA (Pers.) Fries.

On dead wood, Corvallis. April. No. *2573*.

19. ALEURODISCUS CANDIDUS (Schw.) Burt.

On oak, Corvallis. December. Infrequent. No. *1990*.

20. ALEURODISCUS PENICILLATUS Burt.

On hemlock, Corvallis. May. No. *1951*.

This collection was taken within 40 miles of the type locality (Eugene) of this species.

21. HYPOCHNUS PALLESCENS (Schw.) Burt.

On *Pseudotsuga*, Corvallis. Infrequent. May. No. *6885*.

Except *H. echinosporus* (Ellis) Burt, this is the only report of this genus from Oregon.

Family 4. HYDNACEAE

22. HYDNUM IMBRICATUM (L.) Fries.

In coniferous woods, east slope of Mt. Hood, Hood River County. October. Infrequent. No. *6931*.

This collection was made by Dr. L. F. Henderson, who says the specimen weighed 6 lbs.

23. PHLEBIA CINNABARINA Schw.

On *Alnus*, *Quercus* and *Abies*, Corvallis and Cascadia. September to November. Frequent. Nos. *1973*, *1976*, *2011*.

24. PHLEBIA RADICATA Fries.

On *Tsuga heterophylla*, Philomath. November. Frequent. No. *2160*.

Family 5. BOLETACEAE

25. BOLETUS EDULIS Fries.

In sandy soil, Newport. August. No. *2465*.

26. BOLETUS SUBTOMENTOSUS (L.) Fries.

Subalpine to alpine, Mt. Hood. October. No. *2553*.

This collection was made by L. F. Henderson and has a deeply rimose cap, 20 cm. broad.

27. BOLETINUS PICTUS Peck.

Hood River County. October. Frequent. No. *6935*.

Collected by L. F. Henderson. No. *12*.

Family 6. POLYPORACEAE

28. FOMES RIBIS (Schum.) Gill.

On cultivated currant, Corvallis. January. No. *2486*.

Apparently doing very little damage.

29. POLYPORUS BERKELEYI Fries.

On oak stump, Benton County. November. No. *2400*.

30. POLYPORUS CRISPUS (Pers.) Fries.

On hard wood, Corvallis and Blue River. Infrequent. March. Epling Nos. *351* and *657*.

31. POLYPORUS CUNEATUS Murrill.

Blue River, March. Coll. C. C. Epling. Infrequent. No. *2314.*

32. POLYPORUS DELECTANS Peck.

On oak, Corvallis. December. No. *2281.*

33. POLYPORUS DIATORTUS (Schw.).

From old apple stump, Eagle Point. September. Infrequent. No. *7161.*

34. POLYPORUS EPILEUCUS Fries.

On oak, Corvallis. December. Infrequent. No. *2280.*

35. POLYPORUS FUMOSUS (Pers.) Fries.

On decayed wood, Corvallis. November. No. *2418a.*

36. POLYPORUS GUTTULATUS Peck.

On oak (?), Corvallis. September. No. *2414.*

37. PORIA AMBIGUA Bres.

On oak stump, Corvallis. March. Nos. *2278, 2282.*

38. PORIA CARBONARIA Berk. & Curt.

Blue River. March. No. *2354.*

39. PORIA FERRUGINOSA Fries.

Corvallis. November. No. *2332.*

40. PORIA INCRASSATA (Berk. & Curt.) Burt.

On fir flooring in basements and on girders under dwellings, Corvallis and Multnomah. September to January. Nos. *2410, 2411, 2412, 2413, 2408.*

41. PORIA INCRUSTANS (Berk. & Curt.).

In lawns, Hillsboro, and choking out alfalfa, Eagle Point. May. Nos. *2538, 7106.*

42. PORIA MUCIDA Pers.

On oak, Corvallis. October. No. *2020.*

43. PORIA VAILLANTII Fries.

On fir wood in Greenhouse, Corvallis. December. Frequent. No. *7029.*

44. TRAMETES BENZOINA Fries.

On *Abies grandis*, Corvallis. November. Infrequent. No. *2375.*

45. TRAMETES MOLLIS (Sommerfeld) Fries.

On moss-covered log, Corvallis. April. (Epling 705) No. *2296.*

46. TRAMETES TENUIS Karst.

On charred coniferous wood, Waltersville. March. Infrequent. (Epling 584) No. *2310*.

47. MERULIUS AMERICANUS Burt.

On block of *Pseudotsuga taxifolia*, in a cellar and on stumps of same host in woods, Corvallis and Philomath. November. Nos. *2161*, *2162*.

This is the first report of this species west of the Rocky Mts.

48. MERULIUS CORIUM Fries.

On *Cytisus scoparius*, Corvallis. May. Infrequent. No. *6941*.

Collected by H. P. Barss.

49. MERULIUS FUGAX Fries.

On Douglas fir, Corvallis. September. Infrequent. No. *2065*.

50. MERULIUS NIVEUS Fries.

On *Alnus*, Corvallis. December. Infrequent. No. *1992*.

Not previously reported from the Pacific Coast States.

Family 7. AGARICACEAE

51. AMANITA CALYPTRODERMA Atk. & Ballen.

In open woods, Corvallis. April and in the Fall. Frequent. No. *6904*.

Large plants were brought in by Dr. H. M. Gilkey in April. These plants were 16–20 cm. high and the caps were 12–14 cm. in diameter. Morphologically they were typical but cystidia were found very scatteringly. These are obovate, smooth, 18–25 × 12–15 μ.

52. AMANITA PANTHERINA Fries.

In coniferous wood, Corvallis. April. Frequent. No. *6905*.

A collection of this species was brought in by Dr. Helen Gilkey and I believe it is the first report of the species from North America. The plants in every way fulfil the description of *A. pantherina* as given by Ricken. The basidia are 45–50 × 10–12 μ and the spores are ellipsoidal with characteristically blunt ends. The white remains of the volva are left irregularly in small patches on the pileus. On some plants, they are rather sparingly scattered, as illustrated by Ricken. Unfortunately the writer

does not have at hand authentic material of *A. pantherinoides* Murrill but, from description, this is distinct. In this the spores are larger, the gills are free but not sinuate, nor is the stipe glabrous as described for *A. pantherinoides*.

During the Spring of 1927, two persons at Scio, Oregon, were severely poisoned by eating this fungus. I learned from the attending physician that they were unconscious for about 10 hours, with occasional states of spasms, accompanied by tightly set jaws and widely open eyes. From this, they lapsed into a delirious condition before regaining consciousness. Both patients recovered. Plants collected in the same locality where those causing poisoning were obtained had pilei which shade from tawny-olive in the younger specimens to cinnamon-buff or even pinkish-buff in expanded mature specimens.

53. **Lepiota decorata** Zeller, n. nom.

Syn. *Lepiota pulcherrima* Zeller (Myc. **14**: 186. 1922)—not *Lepiota pulcherrima* Graff. (Phil. Jour. Sci. **9**: **C**: 244. 1914.)

54. ARMILLARIA AMIANTHINA (Fries) Kauffman.[2]

In open woods, Corvallis. November. No. *6862*.

55. TRICHOLOMA RUTILANS Fries.

On Douglas fir wood in damp woodlands, Corvallis. Rather frequent. October to December. No. *2391*.

This wood-inhabiting Tricholoma as it grows in Oregon has the sterile cells at the gill margins as illustrated by Ricken.

56. CLITOCYBE AMARA Fries.

In mixed woods, Corvallis. October to December.

According to Dr. C. H. Kauffman *Tricholoma bicolor* Murrill is referable here. The writer has studied several collections of Oregon material and finds no way to distinguish it from Ricken's description of *C. amara*.

57. CLITOCYBE TABESCENS Bres.

On rotted wood in the soil, Corvallis. December. Nos. *2382*, *6859*.

The Oregon collection is typical. The spores are spheroid-ellipsoid, 6–7 μ, and basidia are 21 $\times$ 11 μ. Edible.

58. COLLYBIA CONIGENOIDES Ellis.

[2] Kauffman, C. H. The genus Armillaria in the United States and its relationships. Papers Mich. Acad. Sci., Arts, Letters **2**: 53–67. 1922.

On cones of *Pseudotsuga taxifolia*, Corvallis. November. Not uncommon. No. *6863*.

The Oregon plant is similar to that occurring in the eastern and middle United States. The spores are minute, smooth, unequal, oblong, 3–4 × 2 μ. The cystidia are numerous on the edges of the gills but also scattered in the hymenium. They are lanceolate and often crowned, 30–55 μ long. The characters of the stipe conform to those mentioned by Kauffman.[3]

59. CANTHERELLUS ALBIDUS Fries (?).

Rocky woods, Hood River County. March. Infrequent. No. *6937*.

Dr. L. F. Henderson took this collection. It conforms quite closely with Ricken's description of this species.

60. CANTHERELLUS CINEREUS (Pers.) Fries.

On ground, Corvallis. March. Infrequent. Collected by C. E. Owens. No. *6930*.

61. CANTHERELLUS TUBAEFORMIS Fries.

Hood River County. Infrequent. October. Collected by L. F. Henderson. No. *63*.

62. LENTINUS LEPIDEUS Fries.

On oak posts, Corvallis. July. No. *2364*.

This fungus was collected on *Pinus ponderosa* at many stations in Central Oregon by Prof. W. E. Lawrence.

63. PHOLIOTA BLATTARIA Fries.

Under *Acer macrophyllum*, Corvallis. December. No. *6858*.

This species previously has been reported as far west as Missouri. The spores are 7–8 × 3–4.5 μ and the clavate to fusiform cystidia on edges of the gills are 30–40 × 8 μ. The tramal tissues are composed of large hyphae with vesiculate cells up to 60 × 22 μ. The annulus is striate above as shown in Ricken.

64. PHOLIOTA MARGINATA Fries.

Hood River County. October. Frequent. No. *6936*. Collected by L. F. Henderson. No. *52*.

65. HEBELOMA FASTIBILE Fries.

In oak woods, Salem. December. No. *6860*.

[3] Kauffman, C. H. Agaricaceae of Michigan. Mich. Geol. and Biol. Survey Pub. **26** (Biol. Ser. 5). 1918. (*See p. 772.*)

The Oregon material conforms very closely with Ricken's description of European collections.

66. BOLBITIUS VITELLINUS Fries.

On manured soil, Corvallis. May. Frequent. No. *6941.*

67. STROPHARIA SQUAMOSA Fries.

In fir woodlands, Corvallis. November. No. *6865.* Very common.

68. HYPHOLOMA CANDOLLEANUM Fries.

In open oak woods, Monmouth. April. No. *6876.*

The spores are 6.8–8 × 3–4 μ, and the gills are white becoming dull pink and then violaceous as described by Ricken for the European plants.

69. COPRINUS COMATUS Fries.

In rich soil, Corvallis and Newberg. November. No. *2457.*

70. PANAEOLUS PAPILLIONACEUS Fries.

On horse dung, Corvallis. April. Common. No. *6903.*

71. PANAEOLUS RETIRUGIS Fries.

In gardens, Corvallis. April. No. *2456.*

72. PANAEOLUS SUBBALTEATUS Berk.

On enriched soil, Corvallis. May. Infrequent. No. *6940.*

In this collection the spores are 12–14 x 7.5–8.8 μ; basidia 25 × 8–9 μ, and the scattering cystidia are pointedly ellipsoid with brownish tips, often truncate, 30–32 × 7–8 μ.

73. GOMPHIDIUS OCHRACEUS Kauffman.

Under conifers, Hood River County. October. Frequent. No. *6934.*

Collected by L. F. Henderson. Nos. *56* and *58.*

74. GOMPHIDIUS SUBROSEUS Kauffman.

Under conifers, Hood River County. October. Frequent. No. *6932.*

Collected by L. F. Henderson. No. *57.*

It gave considerable satisfaction to examine the collections of these two species of *Gomphidius* for in the Willamette Valley the predominating species of this genus is *G. oregonensis* Peck, while *G. tomentosus* Murrill which occurs frequently in the Cascade Range has not been found in this valley.

75. VOLVARIA SPECIOSA Fries.

On horse dung in cultivated gardens, Corvallis. April to June. Frequent. Nos. *7069, 7080.*

Family 8. LYCOPERDACEAE

76. TYLOSTOMA AUSTRALIANUM Lloyd.

In sandy soil, Ontario. July. Infrequent. No. *1581.*

This species is rarely found in Oregon. The peridium is not colored. The cortex is of the nature of a sand case. The stipe is darker, rather smooth but sometimes with mycelial strands adhering to the lower half. The mouth of the peridium is irregularly torn. The capillitium is hyaline, thick walled, slender with few strongly swollen septa. Spores are subglobose, 4–5 μ, smooth under ordinary power of microscope, granular under strong oculars. The late Mr. C. G. Lloyd has told the writer that this is *T. Berkeleyii* Lloyd but, according to the descriptions, it is nearer to *T. australianum.*

77. TYLOSTOMA POCULATUM White.

In sandy loam, east of Corvallis. Infrequent. October. No. *1923.*

This species has previously been reported from Nebraska, Colorado and Australia. This collection extends the westward range to Oregon.

78. TYLOSTOMA VERRUCOSUM Morgan.

In sandy soil, Linn County, near Corvallis. Infrequent. October. No. *2333.*

79. GEASTER TRIPLEX Jungh.

In coniferous forest, Corvallis. November. No. *2617.*

Family 9. HYMENOGASTRACEAE

80. RHIZOPOGON RUBESCENS Tul. var. VITTADINII Tul.

Under conifers, Corvallis and Hood River. September to January. Nos. *2550, 2562, 7020.*

This, I believe, is the most common *Rhizopogon* to be found in western Oregon. My largest collection, taken on the college campus in December, consisted of 197 fructifications, having a total weight of 3 lbs. 12 ozs.

81. RHIZOPOGON OCCIDENTALIS Zeller & Dodge.

In sandy soils, Newport and Hood River. Frequent. October to December. Nos. *2438, 2551* and *6933.*

All of these collections were taken by Dr. L. F. Henderson, who collected the type specimen many years ago at Moscow, Idaho.

82. GAUTIERIA GRAVEOLENS Vitt.

Under maples, Corvallis. Infrequent. September. No. *2568*. This is the first report of this species west of Ithaca, N. Y.

Family 10. NIDULARIACEAE

83. CYATHUS STRIATUS (Huds.) Pers.

On fir wood, Corvallis. March. Infrequent. No. *2637*.

FUNGI IMPERFECTI

Family 11. PHOMATACEAE

84. PHYLLOSTICTA MAHONIAECOLA Pass.

On *Mahonia nervosa*, near Corvallis. February. No. *2492*.

85. PHOMA GLANDICOLA (Desm.) Lév.

On acorns of *Quercus garpyana*, Corvallis. February. Common. No. *6873*.

86. PHOMA PHILADELPHI Cooke.

On stems of *Philadelphus gordonianus*, Corvallis. May. No. *6834*.

87. CICINNOBOLUS UNCINULAE Fautr.

Parasitic on *Sphaerotheca Humuli* on salmon berry (*Rubus spectabilis*), Astoria. August.

The open urn-shaped perithecia are membranaceous, 40 × 88 μ, or smaller, and the spores are elongate-ellipsoid, 6–8.8 × 2.5–3.5 μ.

88. FUSICOCCUM PYRORUM Chupp & Clapp.

On die-back apple twigs, Junction City. February. No. *1667*.

89. CYTOSPORA CHRYSOSPERMA (Pers.) Fries.

On poplar, Ontario. July. No. *2537*.

This organism is doing a great deal of damage to poplars in the Boise and Payette Valleys in Idaho and in the Snake and Malheur Valleys in Oregon.

90. CONIOTHYRIUM FUCKELII Sacc.

On Cuthbert red raspberry, Himalaya black berry and Cumberland black raspberry, Corvallis and Newberg. April and August. Very infrequent. Nos. *2653*, *6783*, *6914*.

91. CONIOTHYRIUM HELLEBORI Cooke & Massee.

On *Helleborus niger*, Salem. September. Collected by Mrs. Mary Clemens. No. *2479*.

92. DIPLODIA MAURA Cooke & Ellis.

On winter injured pear bark, Corvallis. January. Infrequent. No. *7186*.

93. SEPTORIA ACERIS-MACROPHYLLI Peck.

On *Acer macrophyllum*, Corvallis. October. No. *2616*.

94. SEPTORIA ALNI Sacc.

On leaves of *Alnus Oregona*, Corvallis. July. No. *2452*.

95. SEPTORIA ALNIFOLIA Ellis & Ev.

On *Alnus Oregona*, Corvallis. June. No. *2514*.

96. SEPTORIA CORYLUS Peck.

On *Corylus Californica*, Corvallis. August. No. *2608*.

97. SEPTORIA NARVISIANA Sacc.

On *Scirpus occidentalis*, Triangle Lake, Lane County. August. No. *6773*.

98. SEPTORIA POPULI Desmz.

On *Populus trichocarpa*, Kiger Island, Benton County. June. No. *2454*.

99. SEPTORIA SALICINA Peck.

On *Salix* sp., Corvallis. September. No. *2614*.

100. SEPTORIA SAMBUCINA Peck.

On *Sambucus glauca*, Corvallis. October. No. *6884*.

101. SEPTORIA STELLARIAE Rob. & Desm.

On *Stellaria media*, Alsea Mt., Benton County. Infrequent. No. *6810*.

This collection made by H. P. Barss is typical, having spores 50–80 × 1 μ.

102. RHABDOSPORA RUBI Ellis.

On canes and fruiting laterals of the wild black raspberry (*Rubus leucodermis* Doug.), Benton County. Infrequent. O. A. C. Herb. No. *4850*.

This fungus was collected by H. S. Jackson, July, 1914. His photograph of it is illustrated in text figure 2.

The spots are purplish to brownish red and become pallid white dotted with the black pycnidia. Pycnidia are 120–160 μ in diameter; spores bacilliform, 25–40 × 1–1.5 μ, hyaline. This is the first report of this parasitic fungus west of Illinois. (FIG. 2.)

FIG. 2. Cane lesions produced by *Rhabdospora Rubi* Ellis on fruiting laterals of *Rubus leucodermis* Doug. Photo by H. S. Jackson.

Family 12. MELANCONIACEAE

103. GLOEOSPORIUM OBTEGENS Sydow.

On *Pteridium aquilinum*, Marion County. August. No. *2506*.

104. MARSSONIA PIRIFORMIS (Riess.) Sacc.

On *Populus alba*, Cottage Grove. September. No. *2611*.

105. SEPTOGLOEUM NUTTALIAE Harkn.

On *Osmaronia cerasiformis*, Corvallis. No. *2610*.

106. CORYNEUM RHODENDRI Schw.

On leaves of *Rhodendron*, Newport. April. No. *6909*.

Spores of this species are 5-septate, constricted at the septa, 17–22 × 6–8 μ, terminal cells hyaline, usually appendiculate.

107. PESTALOZZIA HARTIGII Tubeuf.

On pear seedlings suffering from heat canker, Dillard. August. Infrequent. No. *7091*.

108. PESTALOZZIA TRUNCATA Lev. var. *Rubi* Karst.

On dead canes of *Rubus*, Alpine. April. No. *6812*.

Acervuli gregarious, showing black, elliptical, on a gray background, erumpent; conidia oblong, 3-septate, not constricted, 2 middle cells fuliginous, end cells hyaline, terminal 2–3-ciliate, basal long filiform pedicellate, 13–15 × 6 μ.

109. CYLINDROSPORIUM CRATAEGI Ellis & Ev.

On *Crataegus*, Linn County. June. No. *2455*.

110. LIBERTELLA CORTICOLA A. L. Smith.

This was found growing saprophytically as a die-back fungus, following winter injury. The spores are slightly curved, 25 × 1.5–2 μ.

Family 13. MONILIACEAE

111. OOSPORA HYPOXYLICOLA (Preuss.) Sacc.

On *Plowrightia morbosa*, Corvallis. April. Infrequent. Nos. *2291*, *2297*.

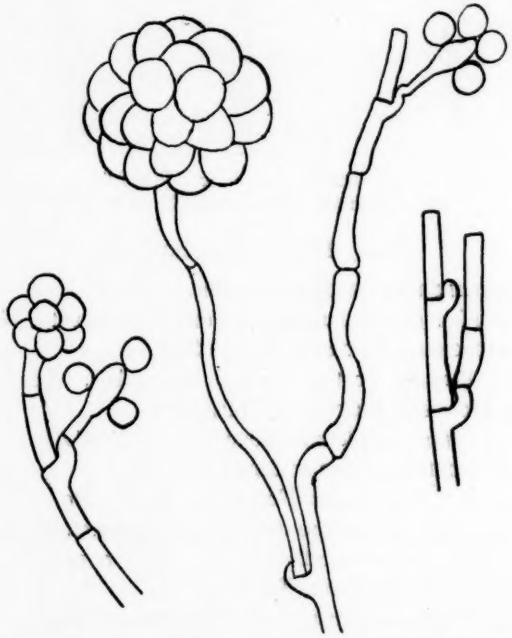

FIG. 3. Mycelium and conidiophores of *Phymatotrichum fungicola* Zeller.

112. **Phymatotrichum fungicola** n. sp.

Hyphae 2.5–4 μ in diameter, hyaline, septate, often with clamp connections and medallions. *Fertile hyphae* arising irregularly, simple or branched, forming with the conidia creamy, pulverulent

masses; *conidia* from swollen heads of the fertile hyphae, subglobose, 6–10 μ in diameter. (FIG. 3.)

Forming pulverulent masses of a creamy white color on the acervuli of *Myxosporium corticola* and *Neofabraea malicorticis*, Corvallis. January to March. Frequently found. No. *6871*.

113. BOTRYTIS POEONIAE Ond.

On dead peony stalks, Corvallis. February. Infrequent. No. *6877*.

The flattened sclerotia adhere to the stalks under the epidermis.

114. OVULARIA OBLIQUA (Cooke) Ond.

On *Rumex*, Corvallis. November. Nos. *2530*, *2555*.

115. CLONOSTACHYS ARAUCARIA Preuss.

Isolated from dead pear bark, Roseburg. August. No. *7035*.

Family 14. DEMATIACEAE

116. CLADOSPORIUM HERBARUM (Pers.) Link.

On black raspberry canes, Independence. March. Frequent. No. *2495*.

Family 15. STILBACEAE

117. STYSANUS STEMONITES (Pers.) Corda.

Isolated from potato tubers by M. B. McKay, Corvallis. February. Infrequent. No. *2629*.

Family 16. TUBERCULARIACEAE

118. FUSARIUM MERISMOIDES Corda.

On stems of *Zea maydis*, Corvallis. Frequent. March. No. *6889*.

This is a very common fungus causing decay of corn stalks in field and silage.

119. FUSARIUM VITICOLA Thüm.

On cultivated currant stems, Corvallis. Infrequent. No. *2476*.

The pink sporodochia were found breaking through the epidermis on dead areas of the stems. The material of the two species of Fusarium was identified by Dr. H. W. Wollenweber.

OREGON AGRICULTURAL COLLEGE,
CORVALLIS, OREGON

NOTES AND BRIEF ARTICLES

The meetings of the mycologists in connection with the American Association for the Advancement of Science held in New York City during the winter were very well attended and the papers presented were unusually interesting. The sessions were presided over by Dr. L. O. Overholts of Pennsylvania State College.

Dr. J. C. Arthur wishes to announce that the book on "The Plant Rusts" by himself in collaboration with F. D. Kern, C. R. Orton, F. D. Fromme, H. S. Jackson, E. B. Mains and G. R. Bisby, will be issued early in the year and will be published by John Wiley & Sons, Inc. It is expected that the book will embrace approximately 500 pages with many illustrations. The book will be welcomed by all mycologists.

Professor T. H. Macbride, Associate Editor of MYCOLOGIA and well-known authority on slime-moulds, has digressed from the beaten path long enough to write "In Cabins and Sod-Houses." This work is not at all mycological but is a vivid picture of early Iowa life as known by him and as often recounted to some of us by our parents. The work is published by the State Historical Society of Iowa, is written in the usual scholarly manner and is very readable.

Mr. H. K. Lewcock, who has been spending several years in America trying to discover some bacterial or fungus parasite which can be introduced into Australia to kill off the cactuses, sailed for Australia on January 31. He will spend some time in an attempt to make a practical application of some of the promising discoveries made in this country.